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## Hospitals moving to collaborative drug therapy management

*Pharmacists join CDTM for infectious diseases, antibiotic therapy*

Some 50% of hospitals responding to a survey have some pharmacists engaged in collaborative drug therapy management (CDTM). Although CDTM was perceived as not having a positive financial impact on pharmacy departments, it was seen as having a positive strategic impact by improving the perceptions of hospital administration of the value of pharmacists and facilitating implementation of other pharmacy services.

The Purdue University survey, reported in the *American Journal of Health-System Pharmacy*, says CDTM entails using a multidisciplinary process for selecting appropriate drug therapies, educating patients, monitoring patients, and continually assessing therapy outcomes.<sup>1</sup> It has been suggested that CDTM by pharmacists could be a way to ensure that medications are used appropriately to improve patients' health status, maximize patients' health-related quality of life, reduce frequency of avoidable drug-related problems, and optimize societal benefits from pharmaceuticals. CDTM includes the initiation, modification, or discontinuation of a drug therapy, patient counseling and education, and the identification, resolution, and prevention of potential and actual drug-related problems.

Studies have demonstrated the positive effect of CDTM on patient outcomes, the study said, and there has been a steady growth in the number of state laws and regulations enabling pharmacists to engage in CDTM. The study intended to assess:

1. The extent and scope of CDTM in U.S. hospitals;
2. The association between hospital characteristics, pharmacy director characteristics, and CDTM;
3. Pharmacy director perceptions of CDTM and associations between pharmacy director characteristics, hospital characteristics, and perceptions of CDTM;
4. Hospitals' short- and long-term CDTM plans;
5. And pharmacy directors' views about major facilitators and barriers for CDTM in hospitals.

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## Collaborative agreements with physicians

Study lead author **Joseph Thomas III, PhD**, a professor in the department of pharmacy practice at Purdue University's School of Pharmacy and Pharmaceutical Sciences, tells *Drug Formulary Review* that CDTM has been around for some time and has been used as part of strategies to improve patient care. Collaborative agreements with doctors, he says, allow pharmacists to see patients more frequently and to work together with physicians to develop a therapy plan.

The study found that about half of U.S. hospitals authorize some of their pharmacists to engage in CDTM. Although studies have demonstrated significant positive patient outcomes with CDTM, the extent of CDTM in hospitals has much room for growth. Most of the hospitals

with CDTM authorize pharmacists to adjust a drug's strength, order laboratory or related tests, and change a drug's frequency of administration. But only 32% of the CDTM hospitals allow pharmacists to discontinue a drug, and less than half of the CDTM hospitals (42%) allow their pharmacists to initiate drug therapy.

Hospital pharmacists were most frequently involved in CDTM for infectious diseases or antibiotic therapy, anticoagulation, and parenteral nutrition. The extent of pharmacist CDTM activities varied by disease or treatment area. Hospitals located in cities with larger populations and hospitals having more beds were more likely to have CDTM. Thomas said this result was expected as larger or urban hospitals have larger patient volumes and CDTM may help to increase efficiency in these hospitals by pharmacists sharing the physician workload.

Pharmacy directors perceived positive hospital support for CDTM, and perceived support for CDTM in hospitals that had pharmacists engaged in CDTM was significantly higher than in hospitals that did not have pharmacists engaged in CDTM. Respondents from hospitals with CDTM perceived greater strategic impact for it than those from hospitals without CDTM.

## Little or no financial impact

Little or no financial impact has been associated with implementation of CDTM. Just over 12% of hospitals engaging in CDTM charged patients a fee for pharmacists' CDTM activities. And only 11% of hospitals received insurance reimbursement for CDTM. However, CDTM was seen as having a positive strategic impact. Respondents agreed that CDTM activities enhance upper administration's perception of pharmacists' value and facilitate implementation of other pharmacy services.

Hospitals responding to the survey said they planned in both the short- and long-term for some increase in the number of staff pharmacists involved in CDTM, number of CDTM protocols, and number of diseases or areas for which pharmacists provide CDTM. Hospitals with CDTM indicated larger planned increases than did hospitals without CDTM, possibly due to positive experiences with it.

Respondents identified a shortage of pharmacists and lack of support from physicians and other medical staff as the major perceived barriers to CDTM. Paradoxically, Mr. Thomas said, physician

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### Editorial Questions

Questions or comments? Call **Gary Evans** at (706) 310-1727.



and other medical staff support were perceived to be a major facilitator of CDTM. Thus, he said, it will be critical for pharmacists to get support from physicians and other healthcare providers to increase CDTM in hospitals.

Thomas tells *Drug Formulary Review* he's not sure why some hospitals have CDTM and others don't. He says those hospitals that do use CDTM are able to articulate the positive impact that it has and demonstrate why it should be in use in more facilities. With doctors and other medical staff seen as both facilitators of and barriers to CDTM, he says, hospitals need to be deliberate in developing a strategy for building support among other practitioners.

Pharmacist willingness to participate in collaborative programs is a facilitator to CDTM growth, he said, but staffing can be a problem. He expressed the hope that more pharmacists will be coming out of school with an expectation and desire to be involved in such programs.

*[Editor's note: For more information contact Dr. Thomas at (765) 494-1477 or E-mail him at jt3@pharmacy.purdue.edu.]*

## Reference

1. Thomas J, Murtuzza B, Shu-Wen L, et al. Survey of pharmacist collaborative drug therapy management in hospitals. *Am J Health-Syst Pharm.* 2006;63(24) 2489-2499. ■

## ED interventions can save lives and dollars

*Pharmacy involvement makes difference*

The most commonly documented interventions made by pharmacists caring for emergency department patients included provision of drug information, dosage adjustment recommendations, responses to questions from nursing staff, formulary interchanges, and suggestions on initiating drug therapy, researchers found. An analysis indicated potential cost avoidance attributable to the study period pharmacist interventions was more than \$1 million.

The study was conducted at Detroit Receiving Hospital, a 340-bed, university-affiliated, urban Level 1 trauma center for adult patients in Detroit, MI. Emergency medicine pharmacy services are

provided through an emergency department satellite where pharmacists are equipped to dispense commonly prescribed oral medications and prepare necessary IV medications. Types of services provided by pharmacists include drug information consultations, pharmacokinetic consultations, anticoagulation services, medical staff inservices, emergency resuscitation team participation, antimicrobial surveillance, patient recruitment for research, order entry and dispensing of medications, formulary interchange, and sample medication provision to indigent care patients.

All pharmacists working in the hospital emergency department prospectively documented interventions that were accepted by physicians and nursing staff weekly between September 1, 2003, and December 31, 2003.

During the four-month study, 2,150 interventions were documented. Some 31% were on the day shift, 33% on the afternoon shift, and 36% during the night shift. A cost avoidance model extrapolated to a full year indicated a potential cost avoidance of just over \$3 million.

## Benefits seen

A beneficial effect of having a clinical pharmacist involved in emergency department patient care was observed in the study, based on the number of accepted pharmacist interventions and the potential cost avoidance, the authors concluded. In addition to the financial benefits, they say, current trends in medicine highlight the necessity of clinical pharmacists in busy emergency departments, which coincides with the heightened public awareness of adverse medication events that have occurred in emergency departments. "The pharmacist's role in medication safety is integral," the authors note. "The pharmacist can potentially minimize medication errors and adverse events, answer general medication questions, and recommend cost-saving equivalent therapies, as well as provide patient-specific medication education.

They concede several limitations in their study, including pharmacists' comfort levels with making recommendations, since pharmacists rotate shifts and are not consistently in the emergency department. Still, after more than 20 years of emergency department clinical services at the hospital, the pharmacists are maintaining a high level of quality interventions, the report says, ensuring patient safety, and continually containing costs. Addition of a clinical emergency medicine pharmacy specialist and an emergency medicine-trained pharmacist

will foster collaboration with other emergency department staff to improve overall performance and care while optimizing a safer and more productive environment for all patients and members of the healthcare team. They recommend that future emergency medicine research should focus on development and subsequent validation of an economic model for evaluating pharmacist-provided emergency care.

[Editor's note: For more information contact Ms. Lada at (617) 638-8000 or E-mail [pamela.lada@bmc.org](mailto:pamela.lada@bmc.org).]

## Reference

1. Lada P, Delgado G. Documentation of pharmacists' interventions in an emergency department and associated cost avoidance. *Am J Health-Syst Pharm.* 2007;64(4):63-68. ■

# Drug-related hospitalizations: A preventable problem?

*Reductions are possible with right strategy*

Studies in the U.S. estimate that adverse drug events account for up to 28% of emergency department visits and 25% of ambulatory care encounters and that up to 70% of these visits are preventable. A Canadian study reported in *Pharmacotherapy* says that in addition to the morbidity and mortality associated with adverse drug events, the resulting costs contribute to the overall pressures on the healthcare system.<sup>1</sup>

In Canada, the report says, there has been limited research to characterize the impact of drug-related hospitalizations. There was a 2004 Canadian Adverse Events Study that evaluated adverse events in Canadian hospitals, but it was not designed to evaluate adverse drug events resulting in hospitalization. Also, most research has been retrospective and resulted in inherent methodologic limitations, such as possible underestimation of the problem.

"In this era of increased attention to improved patient safety coupled with continuing budget restraints, accurate characterization of drug-related hospitalization is an important step toward reducing the potentially significant burden such problems place on our healthcare system," the report said. "The purpose of this study was to prospectively evaluate the frequency, severity, preventabil-

ity, and classification of adverse drug events resulting in hospitalization in an internal medicine service of a large tertiary care hospital, and to identify any patient, prescriber, drug, and system factors associated with these events."

Study author **Peter Zed**, PharmD., at Vancouver General Hospital in Vancouver, British Columbia, tells *Drug Formulary Review* that as patient safety has evolved, there have remained unanswered questions about drug-related epidemiology and it is important to have a clear picture of the impact of patients presenting with drug-related causes. He says the study clearly showed it is possible to have an impact in reducing drug adverse events. Adverse drug events are defined as unfavorable medical events related to drug therapy.

## 72% deemed preventable

The study looked at consecutive adult patients admitted to the Vancouver General Hospital internal medicine units during a pre-defined 12-week period from January 10 to April 4, 2005. Primary study outcomes were the frequency, severity, preventability, and classification of drug-related hospitalizations.

During the 12-week study period, 739 patients were admitted to the internal medicine service at Vancouver General Hospital and 565 patients were included in the final analysis. Drug-related hospitalizations occurred in 136 patients (24.1%), of which 98 (72.1%) were deemed preventable. Adverse drug reactions, improper drug selection, and non-compliance were the most common classifications of drug-related hospitalization.

Overall, a total of 167 drugs were implicated in the 136 drug-related hospitalizations. In 105 of the 136 hospitalizations, a single drug was associated with hospitalization, whereas in 31 hospitalizations, several drugs were implicated. The most common drug classes associated with drug-related hospitalization were cardiovascular agents (27.5%), antibiotics (23.4%), nonsteroidal anti-inflammatory drugs (13.2%), central nervous system agents (7.8%), anticoagulants (5.4%), and hypoglycemic agents (4.8%). The most common agents associated with drug-related hospitalizations were aspirin (14%), furosemide (7.4%), ciprofloxacin (7.4%), warfarin (6.6%), ramipril (6.6%), and spironolactone (5.9%).

Zed says analysis shows the occurrence of drug-related hospitalization was independent of age, sex, number of prescription drugs prescribed, number of OTC drugs taken, use of complemen-

tary and alternative medicine, impaired renal function, use of a compliance aid, use of more than one pharmacy, use of a regular family physician, and use of more than one prescriber.

Although 83.8% of patient outcomes associated with drug-related hospitalization were moderate in severity, 7.4% were considered severe, and 0.7% resulted in death.

*[Editor's note: For more information contact Mr. Zed at zed@interchange.ubc.ca.]*

## Reference

1. Samoy LJ, Zed, PJ, Wilbur K, et al. Drug-related hospitalizations in a tertiary care internal medicine service of a Canadian hospital: A prospective study. *Pharmacotherapy*. 2006;26(11):1578-1586. ■

# Telepharmacy helps to improve pharmacy services

*Rural pharmacy able provide broader services*

A 25-bed critical access hospital that wanted to improve pharmacy services through use of automated dispensing machines and remote pharmacist review of orders found telepharmacy could help it achieve its objectives, a researcher found.<sup>1</sup>

Telemedicine is defined by the Institute of Medicine as "the use of electronic information and communications technologies to provide and support healthcare when distance separates the participants." Telepharmacy is a subset of telemedicine that focuses on the pharmacy-related aspects of telemedicine, including dispensing of medications and information and the provision of pharmaceutical care to patients from a distance.

Lead author **Adam Boon**, PharmD., who is now pharmacy operations manager at Iowa Lutheran Hospital in Des Moines, describes the telepharmacy experiment he participated in when he worked at a small critical access hospital in southern Indiana that partnered with Louisville's Jewish Hospital.

The pharmacy staff at the small hospital consisted of Mr. Boon and a half-time pharmacy technician. The daily census averaged 10 patients. The hospital's pharmacy services were run through the 442-bed regional hospital in Louisville. Jewish Hospital provided pharmacy staff, relief staff, and

technical assistance when needed at the rural facility.

Boon says there were great challenges in providing effective pharmaceutical cognitive services at the rural setting, including the main obstacles of a lack of staffing and of funding for new initiatives. To a lesser degree, he says, other health professionals' perceptions of what type of pharmacy services should be provided to the hospital were also a concern.

Trying to improve pharmacy coverage for the rural hospital, after-hour services were made available through the regional hospital, which had 24-hour pharmacy service. While setting up the remote pharmacy coverage, several conditions were established. It was decided that because the regional facility did not provide remote pharmacy services on a regular basis and would not charge the smaller facility for services rendered, after-hours orders would only be processed in emergency situations. The nursing staff would then be able to access the majority of medications on the formulary from an automated dispensing machine. Any questions requiring a pharmacist's input would be referred to the regional hospital whenever the smaller hospital's pharmacy was closed.

## Home work

A pharmacist using a remote computer at the pharmacist's home provided weekend coverage. Orders were faxed to the pharmacist's home and processed throughout the day. Weekend coverage was rotated among three pharmacists.

While there were challenges in setting up the program, Mr. Boon says, there also were factors that allowed for an easy transition permitting implementation of the expanded services. First, pharmacists at Jewish Hospital were licensed in both Kentucky and Indiana. Second, the two hospitals' computer systems were the same and thus pharmacists from each facility knew how to use the system with little or no additional training. The system also allowed the pharmacists to access it from any Internet connection. For weekend coverage, laptop computers were provided to each pharmacist.

Third, the two hospitals used similar formularies. The rural hospital's pharmacy and therapeutics committee adopted a majority of the formulary substitutions allowed at the larger hospital. A copy of all formulary substitutions was made available to all staff involved in assessing and

entering pharmacy orders. The pharmacy computer system was later upgraded to perform an autosubstitution function to identify non-formulary medications and provide the pharmacist reviewing the order with alternate formulary options. That function also enabled the smaller facility to expand its formulary to fit its own needs without having to conform to the larger facility's formulary.

Next, a selection of medications was available through automated dispensing machines. The machines provided quick access to nurses and a faster turnaround time for order processing. All medications available at the rural hospital were stocked in at least one automated dispensing unit within the hospital. Only high-risk medications continued to be stocked only in the pharmacy, and the nursing staff could access the pharmacy only in emergency situations.

Boon tells *Drug Formulary Review* he believes his experience at the rural critical access hospital is replicable in general. "You see it a lot more these days," he says, "including companies that do remote order entry as a service for small hospitals." He says the key to success is a larger hospital with a good information technology department that has the same computer system as the smaller hospital.

[Editor's note: For more information contact Boon at [adb79@msn.com](mailto:adb79@msn.com).]

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1. Boon, A. Telepharmacy at a Critical Access Hospital. *Am J Health-Syst Pharm.* 2007;64(3):242-244. ■



## Web site gives system pharmacy best practices

*Advancement of 'high performance' pharmacy*

A new web site developed by the Health Systems Pharmacy Executive Alliance identi-

fies best practices for improving health system pharmacy operations and recommendations for adopting the practices.

The Health Systems Pharmacy Executive Alliance is a collaboration of well-known leaders who are dedicated to advancing hospital pharmacy's contributions to patient safety, clinical quality, and financial performance through increased effectiveness and efficiencies.

The group's vision is advancement of what it calls the High Performance Pharmacy, a concept that it says enhances and elevates the profession of health system pharmacy, as well as its practice and standing, within healthcare today and in the future.

More than 70 elements of high performance were identified across eight key dimensions — leadership, medication preparation and delivery, patient care services, medication safety, medication use policy, financial performance, human resources management, and education. The study estimated the level of effort required to implement each element and the expected impact on quality, safety, and financial performance.

[Editor's note: Learn more at <http://www.highperformancepharmacy.com>] ■

## New suicide warnings on antidepressants

FDA has proposed that all makers of antidepressants update the existing black box warning on the products' labeling to include warnings about increased risks of suicidality in young adults ages 18 to 24 during initial treatment (generally the first one to two months).

The proposed labeling changes also include language stating that scientific data did not show an increased risk in adults older than age 24, and that adults ages 65 and older taking antidepressants have a decreased risk of suicidality.

The proposed labeling changes apply to the entire category of antidepressants. FDA said results of individual placebo-controlled scientific studies are reasonably consistent in showing a slight increase in suicidality for patients taking antidepressants in early treatment for most of the medications. Available data are not sufficient to exclude any single medication from the increased risk of suicidality, the agency said. FDA also emphasized that depression and certain other serious psychiatric disorders are themselves the most important causes of suicide. ■

## **All Shelhigh medical devices recalled**

FDA issued a formal written request that Shelhigh, Inc., recall all of its medical devices remaining in the marketplace, including hospital inventories, because of sterility concerns. On April 17, U.S. Marshals acted on an FDA request and seized all medical devices, including components, at Shelhigh's Union, NJ; facility after finding significant deficiencies in the company's manufacturing processes. During the seizure, the company was asked for a voluntary recall of its products but it declined.

FDA said Shelhigh devices are used in infants, children, and adults, and include pediatric heart valves, conduits for blood flow, surgical patches, dural patches, annuloplasty rings, and arterial grafts.

The agency said the company's deficiencies, outlined in a complaint filed in New Jersey federal court, may compromise the devices' safety and effectiveness. The company's records indicate a number of sterility test failures and that its testing and retesting procedures were not properly performed, FDA said. ■

## **Avandia safety alert issued**

FDA said it is aware of a potential safety issue related to GlaxoSmithKline's Avandia (rosiglitazone), indicated for treating type 2 diabetes. The agency said safety data from controlled clinical trials have shown a potentially significant increase in risk of heart attack and heart-related deaths in patients taking Avandia. However, the agency said, other published and unpublished data from Avandia long-term clinical trials provide contradictory evidence about the risks in patients treated with Avandia.

The agency said it has not confirmed the clinical significance of the reported increased risk in the context of other studies. Pending questions include whether the other approved treatment from the same class of drugs, pioglitazone (Takeda's Actos), has less, the same, or greater risk. Also, it said, there is inherent risk associated with switching

patients with diabetes from one treatment to another, even in the absence of specific risks associated with particular treatments. For that reason, FDA said, it is not asking Glaxo to take any specific action.

FDA said patients taking Avandia, especially those known to have underlying heart disease or who are at high risk of heart attack, should talk to their doctor about this alert as they evaluate available treatment options for their type 2 diabetes. ■

## **MRI contrast agents should have warning**

FDA has asked manufacturers to include a new boxed warning on product labeling of all gadolinium-based contrast agents used to enhance the quality of MRI images. The requested warning would state that patients with severe kidney insufficiency who receive gadolinium-based agents are at risk for developing nephrogenic systemic fibrosis, a debilitating and potentially fatal disease. The boxed warning would also state that patients just before or after liver transplantation, or those with chronic liver disease, are also at risk for developing nephrogenic systemic fibrosis if they are experiencing kidney insufficiency of any severity.

Five gadolinium-based contrast agents have been approved for use in the U.S.—Bayer Schering Pharma's Magnevist, GE Healthcare's Omniscan, Mallinckrodt's OptiMARK, and Bracco Diagnostics' ProHance and Multihance. ■

## **FDA targets timed-release guaifenesin**

FDA has given companies 90 days to stop producing and 180 days to stop distributing unapproved drug products in timed-release dosage form that contain guaifenesin, commonly used in cough and cold medications to stimulate removal of mucous from the lungs. The action does not affect products containing guaifenesin in immediate release form. Only Adams Respiratory Therapeutics has FDA approval for timed-release products containing guaifenesin (600 mg and 1,200 mg) under the trade names Mucinex and Humibid. ■

## **COMING IN FUTURE MONTHS**

■ Pharmacist interventions help compliance

■ A pain management clinic becomes a revenue generator with a clinical pharmacist

■ Pharmacists need to understand what makes CFOs happy

■ Pharmacists can reduce medication discrepancies

# New FDA Approvals

FDA recently announced these approvals: • Schwartz Bioscience's Neupro (rotigotine transdermal system), a skin patch designed to treat symptoms of early Parkinson's disease. The agency said rotigotine is a drug not previously approved in the U.S. Neupro is the first transdermal patch for treating Parkinson's disease symptoms.

Neupro's effectiveness was demonstrated in one fixed-dose response study and two flexible-dose studies involving 1,154 patients with Parkinson's disease who were not taking other Parkinson's medications. The most common side effects included skin reactions at the patch site, dizziness, nausea, vomiting, drowsiness, and insomnia. FDA said most of the side effects are typical of this drug class. Other potential safety concerns include sudden onset of sleep while engaged in routine activities such as driving or operating machinery, hallucinations, and decreased blood pressure on standing up.

- FDA has cleared for marketing the first respirators that can help reduce a user's exposure to airborne germs during a public health medical emergency such as an influenza pandemic. The two 3M filtering facepiece respirators will be available to the general public without a prescription.

The agency said the devices also are certified by the National Institute for Occupational Safety and

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Health (NIOSH) as N95 filtering facepiece respirators for use in occupational settings in accordance with an appropriate respiratory protection program. An N95 filtering facepiece respirator is a type of face mask that fits tightly over the nose and mouth. It is made of fibrous material that is designed to filter out at least 95% of very small airborne particles. The filter and a proper fit determine the product's effectiveness.

Many companies make N95 respirators for workplaces, including healthcare settings, but 3M's are the first to receive FDA clearance for use by the public during public health medical emergencies to reduce exposure to airborne germs. FDA is requiring those who want to market respirators for use during public health medical emergencies to assure that they are certified by NIOSH to provide adequate filtration without hampering people's ability to breathe. Companies also must conduct fit assessment testing, conduct biocompatibility testing to reduce the chance for allergic skin reaction, and provide instructions that will enable wearers to achieve a protective fit and use the devices properly.

3M evaluated fit characteristics in healthy adults to determine that a user could achieve a protective fit following the label instructions. The company measured how many airborne test particles were able to get inside the respirator through small leaks between the edges of the respirator and the wearer's face. ■

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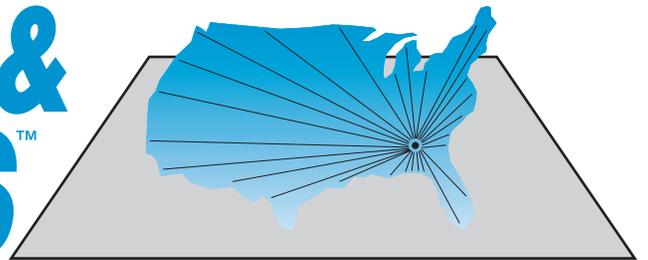
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## Suffer the children: Preventing medication errors in pediatric patients

By **Sarita Bhat**, Pharm.D candidate, Auburn (AL) University Harrison School of Pharmacy

Pediatric patients can be particularly vulnerable to medication errors, but tragedies like that described on a recent national news program can be averted if the factors that lead to such errors are understood and addressed by pharmacists and their clinical partners.

Many people viewed the 20/20 program on ABC at the end of March 2007 that described a young girl, who as an infant, received an anti-diabetic medication instead of her seizure medication.<sup>1</sup> This error led to her having more seizures for several weeks afterwards due to the dangerously low blood sugar levels that resulted from taking the wrong medication. She experienced permanent brain damage, and she now cannot take care of herself. This child has been permanently disabled because of a medication error that could have been prevented. Regardless of who was at fault in this particular case, a number of people are involved in the process of pediatric patients receiving their medication, and all of those people can take steps to prevent these permanently disabling or potentially fatal medication errors.

Before discussing the specifics as to who can do what in the process of receiving drug therapy, one must first understand why the pediatric population is so vulnerable to medication errors. Children present with a distinct set of risks, mainly that of a wide variation in body mass, body surface area, and organ system maturity, resulting in the need for individualized dosing for most drug therapies.<sup>2,3</sup> This individualization involves calculations and sometimes special compounding of products, which leaves a larger margin for errors than a pre-mixed product or a drug product with a set dose. Evidence has shown that harmful errors are three

times more likely in children than in adults in the United States.<sup>2</sup> Also, children are often unable to warn health care providers if they are about to get the wrong medication or if they are having an adverse drug effect.<sup>4</sup>

### ***Wrong dose most common error***

Errors varied between settings such as the pediatric intensive care units, emergency department, or an outpatient setting. Time of shift affected the rates of errors in a neonatal intensive care unit that was studied, as the day shift experienced more errors possibly due to the higher workload at that time.<sup>2</sup> Examples of some of the types of errors seen included wrong dose (most common), drug, route, frequency, missed dose, wrong patient, or drug interaction. In one report, intravenous fluids were the most common product to be involved with medication errors in the pediatric population.<sup>3</sup> According to another review, antibiotics and sedatives (benzodiazepines and barbiturates) were the most commonly implicated drug classes in which errors were made, most likely because these are widely prescribed in the pediatric population. The same review reported that there were more inaccuracies noted with medications that were not approved for use in children.<sup>2</sup> Drugs with low therapeutic indices such as digoxin and phenytoin are more error-prone and require careful monitoring.<sup>5</sup>

Other environmental factors were also implicated in the barriers to patient safety, including fatigue, stress, anxiety, fear of blame, distractions, noise, poor lighting, lack of standardization of equipment or location of supplies.<sup>4</sup> Particularly in emergency departments in many hospitals, medi-

## Tips for avoiding medication errors in pediatric patients

### Physicians:

- Consult guidelines and resources for proper drug names, dosages, route, and drug interactions.
- Do not prescribe drugs for children that you are not familiar with.
- Check for allergies, interactions, and contraindications
- Enter patient's weight as part of the order so that dosage can be verified.
- Watch for "look-alike/sound-alike" drugs.
- Use generic names instead of brand names, and write out complete dosage units such as milligram, microgram, and units.
- Use leading zeros, but not trailing zeros, and use specific instructions.
- Minimize verbal orders and use CPOE whenever possible.
- Consult a pharmacist if there is any doubt about medication indication or dosage.
- Always beware of known drug allergies.
- Write drug orders clearly and include your name written clearly and a contact number.
- Encourage non-punitive medication error reporting.

### Nurses:

- Double-check patient names with medication orders.
- Consult physicians or pharmacists if suspicious of improper drug, dosage, or infusion time.
- Encourage non-punitive medication error reporting.
- If patients or parents question a drug or dosage, listen carefully and verify.
- Be familiar with administration and dispensing devices and the potential for errors within those systems.

### Pharmacists:

- All medication orders should be verified, especially those requiring calculations.
- Any alerts of drug interactions or adverse drug events should be documented and reported to prevent potential trends of the more common errors.
- Physicians and nurses should be notified to discontinue any drugs that have been given that could be potentially harmful.
- Separate "look-alike and "sound-alike" drugs in storage.
- Consider color-coordinating oral syringe and intravenous products so that they are not confused
- Provide patients and parents/guardians with counseling when appropriate, including education and monitoring.
- Encourage non-punitive medication error reporting.

cal residents with limited pediatric expertise are responsible for the majority of care of children, and many of these clinicians have had little to no previous training in pediatrics. Thus the dosing for this population is not familiar to them and moreover, there are no systems for verifying their competence at most facilities.

Based on trends in pediatric medication errors nationally, there are actions that may be taken to reduce the risk of fatal or permanently disabling pediatric medication errors in all departments of a health system or outpatient setting. One method that has been suggested is computerized physician order entry (CPOE), and it has proven to be effective in that the orders are complete, legible, and standardized.<sup>4</sup> Additionally, robots and smart intravenous pumps have shown promise in reducing dispensing errors and would improve overall reliability of the system. Furthermore, the availability of practice guidelines and formatted templates at the physicians' fingertips would help gain pertinent and critical information from the patient. The role of clinical pharmacists on patient rounds may also have a significant impact on decision making for critically ill patients, but in reality everyone in a health care environment must be proactive to prevent pediatric medication errors from occurring, as listed in Table <sup>1,2,3,5</sup>

### ***An early focus of clinical education***

If everyone involved in the medication use process for pediatric patients is properly educated with a quality assurance plan in place, along with a periodic review, then pediatric medication errors should be kept to a minimum, and health care costs will be reduced. This education may be implemented early in the careers of pharmacy students, nursing students, and medical residents. Studies have shown that although educational programs for medical residents and other medical staff have had an impact on reducing medication errors in pediatrics, implementing systems for prevention of errors are more important.<sup>5</sup> Organizations such as The Joint Commission and the Leapfrog Group have been directing health systems to adopt these types of improvements<sup>4</sup> Parents should particularly be aware of their children taking sedative drugs in the outpatient setting, as severe harm is more likely to occur in this setting than the inpatient setting, since the patient is not directly monitored by a health care provider.<sup>6</sup> If parents take an extra step in verifying their child's medication, then incidents such as the permanently disabling

harm endured by the young girl described above will hopefully become nonexistent. Ultimately each individual involved in the well-being of an ailing child should take the responsibility to make sure that the child stays safe and recuperates.

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## Drugs that harm bugs ...and the liver?

By Joe Ybarra, Pharm.D candidate, Auburn (AL) University Harrison School of Pharmacy

Antibiotics are one of the most abundantly prescribed medications in both the outpatient and inpatient settings. From treating a simple infection to a life-threatening one, antibiotics decrease morbidity and mortality in every patient population. However, agents may cause undesirable adverse effects that may be as harmful to the patient as the disease being treated. These adverse events cause increased cost of health care and prolonged duration of hospital stay, and may be avoided with appropriate monitoring measures and knowledge of pharmacotherapeutics. Liver injury associated with telithromycin (Ketek®), a ketolide, has recently increased vigilance of these adverse events.

An article in the *Annals of Internal Medicine* first addressed the issue of telithromycin-induced hepatotoxicity in January 2006, after three cases were reported — one ended in spontaneous recovery, one resulted in liver transplantation, and one

resulted in death. The two patients with negative outcomes had an underlying history of alcohol use. In June 2006, the FDA issued a labeling supplement informing practitioners and patients of the risks of hepatotoxicity associated with telithromycin. Recently, in February 2007, the FDA has made changes to its approved indications to only treat mild to moderate community-acquired pneumonia caused by *S. pneumoniae*, *Haemophilus influenzae*, *Chlamydia pneumoniae*, *Moraxella catarrhalis*, or *Mycoplasma pneumoniae* for adults over 18 years of age. Telithromycin is not the sole antibiotic attributed with these adverse effects; therefore, many classes of antibiotics have the potential for harmful properties varying from liver enzyme elevation to death. Appearing in the 1960s, erythromycin estolate was the first macrolide recognized to cause of hepatotoxicity in primarily the adult population, and today application is only limited to pediatric populations. All esters of erythromycin have some degree of cross-reactivity and the potential to cause harm to the liver. Increased utilization of less harmful formulations such as erythromycin base greatly reduced the incidence of hepatotoxicity with erythromycin.

Reports of liver injury have been associated with usage of antistaphylococcal, natural, semisynthetic, and broad-spectrum penicillins, with a wide spectrum of symptoms ranging from liver enzyme elevation to death. The first and second-generation cephalosporins rarely induce hepatotoxicity; however, the third-generation cephalosporin, ceftriaxone, has been reported to cause biliary sludge and pseudolithiasis. The carbapenem, imipenem, has not been associated with cholestatic liver injury itself; however, when in combination with cilastatin (contained in Primaxin®) hepatotoxicity has been reported.

The intravenous formulation of tetracycline has a history of causing significant injury to the liver; high risk patients include those taking greater than 1.5 grams a day, women in their third trimester of pregnancy, and men taking estrogen to treat prostate cancer. As a consequence of this adverse effect, the use of intravenous tetracycline is very rare. Other tetracyclines, such as minocycline, doxycycline, and oral tetracycline, are relatively safe to use in the adult population. Patients who are HIV-positive and receiving sulfonamide or dapson therapy are also at an increased risk for liver injury. While not studied in HIV-positive patients, trimethoprim monotherapy has caused recurrent hepatotoxicity in patients with a previous history of liver failure caused by trimethoprim-sul-

famethoxazole. Patients with tuberculosis are at increased risks of adverse effects with antibiotic therapy; however, other comorbidities are common in this population. Comorbidities such as alcoholism, old age, hepatitis, HIV, AIDS, malnutrition, and alterations in acetylase status, should be ruled out when identifying the cause of liver injury. Of the antibiotic agents used in long-term treatment, pyrazinamide is repeatedly the most common cause of drug-induced liver injury. This often occurs in a combination regimen of pyrazinamide plus isoniazid and rifampin, a CYP-inducer. Isoniazid and ethambutol, in monotherapy, have a rare incidence of causing hepatotoxicity.

Antimicrobial agents are the leading class of drugs associated with hepatotoxicity. From liver enzyme elevation to cirrhosis to death the degree of injury varies with the use of each agent. The time of onset varies from immediate to delayed (few days to a few months) after therapy is initiated; therefore, educating patients to the possibility of the signs and symptoms of liver disease occurring well after antibiotics are finished, may prevent significant morbidity. Caution is advised when administering these medications to patients with active or previous episodes of liver disease, receiving concurrent hepatotoxic medication regimens, and consuming alcohol on a regular basis. To eliminate any adverse events associated with its use, intravenous tetracycline should be removed from hospital formularies. Baseline liver enzyme tests should be conducted when initiating pyrazinamide along with other medications used in tuberculosis management. While telithromycin has recently gained notoriety as a hepatotoxic agent, vigilance must be taken to identify newly initiated medications or the existence of concurrent disease states that increase the possibility of hepatic disease.

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## 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.
25. Children present with a distinct set of risks for adverse outcomes related to medication errors including a wide variation in:
    - A. body mass
    - B. body surface area
    - C. organ system maturity
    - D. all of the above
  26. Which of the following was the most common medication error in a study of pediatric patients?
    - A. wrong dose
    - B. missed dose
    - C. wrong patient
    - D. drug interaction
  27. It is recommended that pharmacists consider color-coordinating oral syringe and intravenous products so that they are not confused.
    - A. True
    - B. False
  28. In a report of three cases of telithromycin-induced hepatotoxicity one patient needed a liver transplant and another died. The two patients with negative outcomes had an underlying history of:
    - A. hepatitis C infection
    - B. frequent use of acetaminophen
    - C. alcohol use
    - D. elevated liver function levels