PA PSRS Pennsylvania Patient Safety Reporting System

Patient Safety Advisory

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SUPPLEMENTARY ADVISORY

Results of the PA-PSRS Workgroup on Pharmacy Computer System Safety

Background

An important way to prevent serious adverse drug events is with the use of a robust pharmacy computer order entry system. All too often tragedy results when pharmacy computers fail to detect unsafe drug orders during order entry. With the technology available today, we can integrate automated alerts into healthcare information systems that have the capability to catch many errors before they reach patients. Yet, since its inception in June 2004, the Pennsylvania Patient Safety Reporting System (PA-PSRS) has received a number of reports that suggest pharmacy computer systems in Pennsylvania facilities are not detecting unsafe drug orders as well as they could.

For example: A 30-year-old patient was ordered **PERCOCET** (325 mg acetaminophen and 5 mg oxycodone). The patient also was ordered **DARVOCET N-100** (650 mg acetaminophen and 100 mg propoxyphene) 2 tablets every 3 hours as needed. During day one, the patient received 2 Percocet tablets and 6 Darvocet N-100 tablets, resulting in a total daily acetaminophen intake of 4,550 mg. On the following day, this same patient received 8 tablets of Darvocet N-100 for a total daily acetaminophen intake of 5,200 mg.

While this patient did not suffer severe liver damage or other harm from receiving more acetaminophen than the maximum daily dose of 4,000 mg, it is easy to see how critical dose and interaction checking limitations in pharmacy computer systems can place patients at risk. In this case, the facility's pharmacy computer system (and computerized prescriber order entry system) failed to stop two potentially dangerous orders: (1) a Darvocet order that could result in a total daily dose of 10,400 mg acetaminophen, and (2) orders for Percocet and Darvocet that, when combined, resulted in an unsafe daily dose of greater than 10,750 mg acetaminophen.

This problem is not unique to Pennsylvania facilities. In 2005, an Institute for Safe Medication Practices (ISMP) nationwide pharmacy computer system field test showed that little improvement had occurred during the prior six years with pharmacy computer systems to safeguard against medication errors.[1] Findings from ISMP's 1999 field test demonstrated that pharmacy computer systems in the United States were unreliable at detecting and correcting prescription errors or pharmacy order entry errors.[2] In many areas, pharmacy computer systems in 2005 performed *less* reliably than in 1999.[2]

PA-PSRS Workgroup on Pharmacy Computer System Safety

In December 2006, PA-PSRS invited Pennsylvania hospitals to voluntarily participate in the PA-PSRS Workgroup on Pharmacy Computer System Safety. The objective of the workgroup was to help the hospitals assess the safety features and capabilities of their pharmacy computer systems. Thirty hospitals participated in the workgroup.

The workgroup required the hospital's patient safety officer to work collaboratively with the hospital's pharmacy department to conduct a pharmacy computer system field test. The field test involved

- creating a test patient in the pharmacy's computer system to ensure that an active patient's medication profile would not be compromised;
- entering 18 unsafe medication orders, which PA-PSRS provided, into the test patient's profile;
- recording whether or not the pharmacy computer system detected the unsafe orders; and
- completing a brief online questionnaire.

Test Condition	PA-PSRS 2007 N=30	ISMP 2005 N=182
Allergy — *Food/Drug*		
Fluzone 0.5 mL IM (patient allergic to eggs)	63%	43%
Drug Interaction — *Drug/Drug*		
rifampin and saquinavir	77%	73%
Drug Interaction — *Drug/Herbal*		
St. John's Wort and indinavir	40%	23%
Wrong Route		
vinicristine 2 mg intrathecal	40%	35%
Lantus 25 units IV now	27%	30%
Overdose — *Age/Child*		
carbamazepine 400 mg BID (4-year-old patient)	40%	31%
Overdose — *Adult*		
amphotericin B 260 mg IV	33%	42%
carbamazepine 1,300 mg PO BID	50%	46%
Overdose — *Diagnosis*		
methotrexate 7.5 mg PO daily (treatment for rheumatoid arthritis)	27%	29%
Overdose — *Weight/BSA*		
lomustine 190 mg PO daily for 6 weeks (BSA = 1.46 m^2)	30%	25%
Duplicate Therapy — *Same drug/Class*		
Lovenox and heparin	90%	84%
Zyban and Wellbutrin SR	90%	81%
Duplicate Therapy — *Combination Drug*		
acetaminophen and Percocet (2005)	—	71%
Percocet and Darvocet N-100 (2007)	93%	—
Contraindication		
Wellbutrin and seizure disorder	20%	18%
Sporonox and congestive heart failure	17%	13%
Varivax and pregnancy	33%	19%
Lab Monitoring		
metformin 500 mg BID (Cr = 2.1 mg/dL)	43%	45%
Neutra-Phos-K 2 packets PO TID (K = 6.1 mEq/L)	30%	31%

Table 1. 2007 PA-PSRS and 2005 ISMP Unsafe Order Detection Results

In return for their participation, the hospitals received

- insight into their pharmacy computer system's safety performance;
- a list of unsafe orders and types of orders that, if not caught by the pharmacy system, the hospital and/or pharmacy computer system vendor could address to prevent future errors; and
- an automated, online report providing the hospital's results as well as aggregate statewide results.

Results

Findings from the 30 Pennsylvania hospitals that participated in the PA-PSRS Workgroup on Pharmacy Computer System Safety show that we are not using the error-catching features of pharmacy computer systems to their full potential or that the systems are incapable of preventing these errors.

Many systems performed poorly when tested with specific questions to assess their ability to detect serious or fatal errors reported to PA-PSRS and/or ISMP (see Table 1). None of the 30 systems tested in the PA-PSRS workgroup were able to detect all the unsafe orders presented in the field test, and one system only detected 1 unsafe order (see Figure 1). The average number of unsafe orders detected was 8 (44%), and the greatest number of unsafe orders detected by a facility was 17 (94%).

Because participants were not randomly selected, the field test results cannot be generalized to all Pennsylvania facilities. However, the results do highlight room for improvement in pharmacy computer systems' ability to detect orders for medications that exceed published safe maximum doses. For example, only 40% of the systems tested detected a serious overdose of carbamazepine for a 4-year-old child. Less than a third of systems detected a significant overdose of lomustine based on the patient's body surface area (BSA), or a potentially fatal overdose of methotrexate for a patient being treated for rheumatoid arthritis. Only one in three systems were able to detect a potentially deadly order for

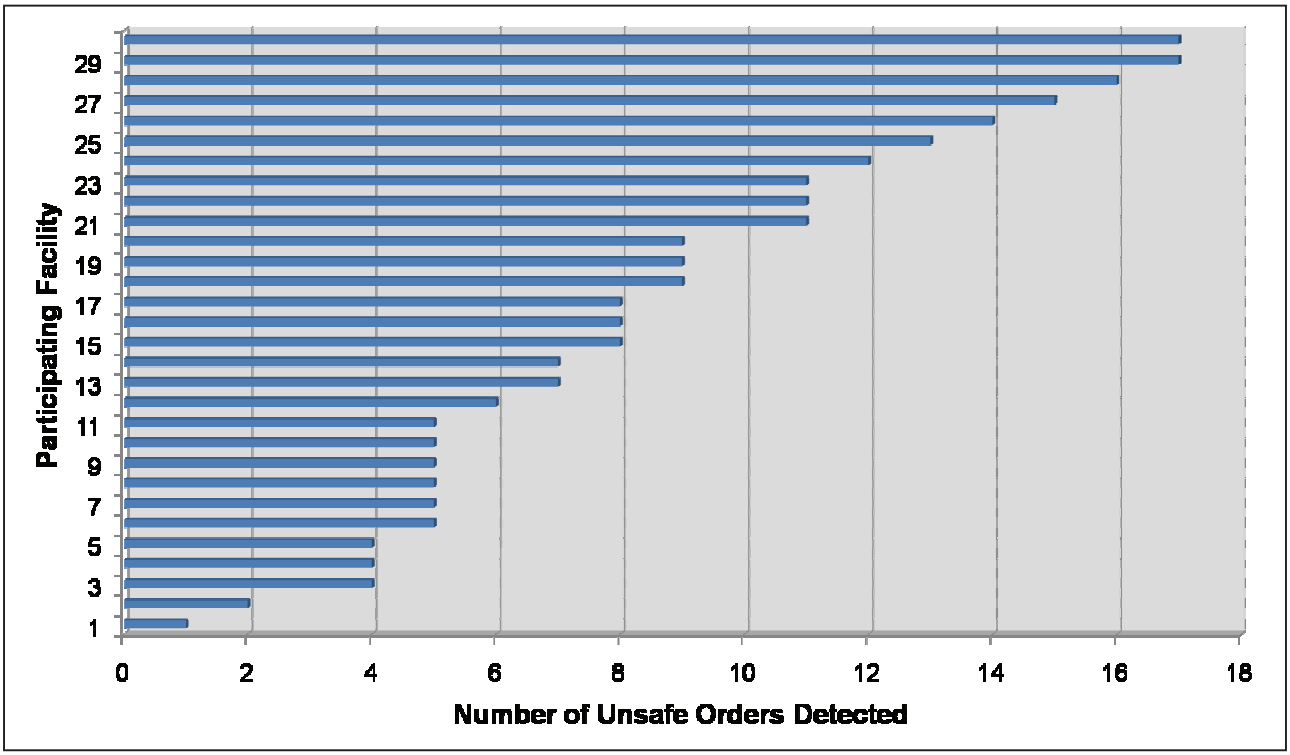

Figure 1. Detection of Unsafe Orders

Statements	2007 PA-PSRS Yes	2005 ISMP Yes
1. Alerts that have little or no clinical significance routinely appear on the screen.	50%	72%
2. Alerts that have little or no clinical significance can be eliminated easily.	70%	60%
3. The system allows you to build alerts for serious error-prone situations (e.g., look-alike names, special precautions).	90%	73%
4. The system allows you to use tall-man letters to differentiate between look-alike drug name pairs (hydrOXYzine, hydrALAzine).	67%	57%
5. The system allows you to change font or color to highlight look-alike drug name pairs to prevent confusion.	13%	9%
6. The system produces computer-generated medication administration records, which are used in the hospital.	87%	81%
7. The system is directly interfaced with the laboratory system.	67%	72%
8. The system allows for direct prescriber order entry AND prescribers directly enter at least 75% of all medication orders.	7%	21%
9. The system is capable of providing reports of drug warning overrides by staff.	93%	82%
10. The system is integrated with a point-of-care bar-coding system used on patient care units during drug administration.	17%	16%

Table 2. Pharmacy Computer System Characteristics

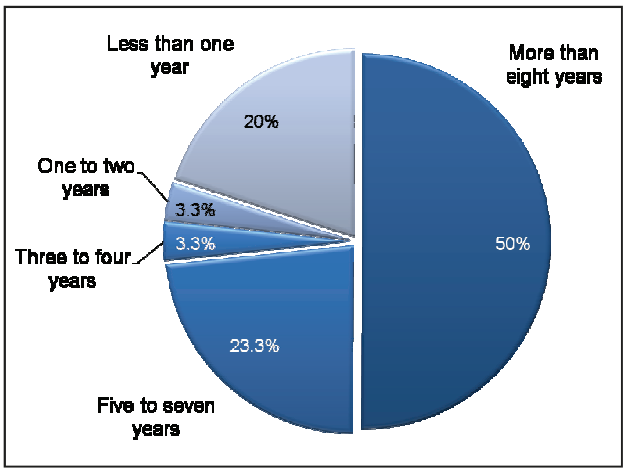

Figure 2. Age of Pharmacy Computer Systems

conventional amphotericin B dosed according to its liposomal form.

A majority (63%) of the workgroup participants' pharmacy computer systems alerted pharmacy staff when an order for **FLUZONE** (influenza virus vaccine) was entered for a patient allergic to eggs. (FLUZONE contains an ingredient derived from eggs.) However, only 40% of the systems flagged the "wrong route" error in an order for intrathecal vincristine, which has resulted in fatalities. Less than one-third of facilities' systems detected an order for **LANTUS** (insulin glargine [rDNA]) to be administered intravenously. Just one in three systems intercepted the entry of a contraindicated drug based on the patient's diagnosis or condition (i.e., pregnancy).

When the pharmacy systems detected unsafe test orders, an average of nearly 9 in 10 systems allowed the users to override these serious warnings. In most cases, the warnings could be bypassed simply by pressing a function key. The chance of overlooking these important alerts is further heightened when considering that clinically insignificant alerts routinely appeared on the screens of 15 out of 30 systems tested (see Table 2).

Systems fared poorly against contraindicated drugs or doses based on lab results even though 67% of pharmacy systems were directly interfaced with the laboratory system. Despite this interface, just 30% of Pennsylvania systems alerted pharmacists when an order for **NEUTRA-PHOS-K** (potassium and phosphorous) was entered for a patient with an elevated serum potassium, and less than half alerted staff when an order for metformin 500 mg BID for a patient with an elevated serum creatinine was entered.

PA-PSRS workgroup participants' pharmacy systems fared well at detecting duplicate therapy. Nine out of 10 systems were able to detect duplications of **ZYBAN** (bupropion sustained release) and **WELLBUTRIN SR** (bupropion sustained release) or **LOVENOX** (enoxaparin) and heparin duplications. Three-quarters of the systems were also able to detect a significant drug/drug interaction. However, less than half were able to detect a clinically significant drug/herbal interaction.

Eighty-seven percent of the computer systems tested were able to produce computer-generated medication administration records. Most systems also provided reports of drug warning overrides and allowed staff to build alerts for serious error-prone situations. However, only two-thirds of the systems allowed the use of tall man letters to differentiate look-alike drug names, and just 13% allowed users to change the font and color to highlight look-alike drug name pairs.

New or updated technology may be one possible solution to the performance gap, though the workgroup's results did not establish a clear relationship between the age of the system and its ability to detect unsafe orders. Half of the participants in the workgroup had a pharmacy system that was at least 8 years old (see Figure 2). Another 23.3% had been using the same pharmacy computer system for 5 to 7 years. Systems greater than 8 years of age detected an average of 9 out of 18 orders, and systems 5 to 7 years of age detected on average 6 of 18 unsafe orders (see Figure 3). However, systems less than 1 year old detected 13 of 18 unsafe orders on average.

Improved pharmacy technology could help reduce the risk of serious patient harm from medication errors. Yet, complex self-programming and a substantial time commitment are necessary to achieve optimal results. Ideally, pharmacy system applications would be user friendly, alert only when clinically appropriate, allow for user-defined alerts, follow user workflow, ensure that upgrades and maximum capabilities can be achieved easily, and be affordable.

All Pennsylvania hospitals participating in the workgroup received and updated drug information for their systems at least quarterly (see Figure 4). Approximately 56.67% of the facilities received drug information monthly, 36.67% quarterly, and 6.67% weekly. Additionally, roughly two-thirds (66.6%) of respondents indicated that it takes 2 months or less to integrate new drug interactions reported by the FDA (see Figure 5).

However, if the vendor deems certain types of alerts unimportant, they may be absent; or if the content provided by the drug information provider is not current or adequate, important alerts will not appear. For example, the drug information vendor's software may not alert staff to unsafe single (one-time) doses. While the system may contain dose limits for drugs with a routine frequency, it may contain limited information for single doses. Consequently, an alert for a single dose that exceeds safe limits may not appear, and the user may not be notified that a dose check was not performed.

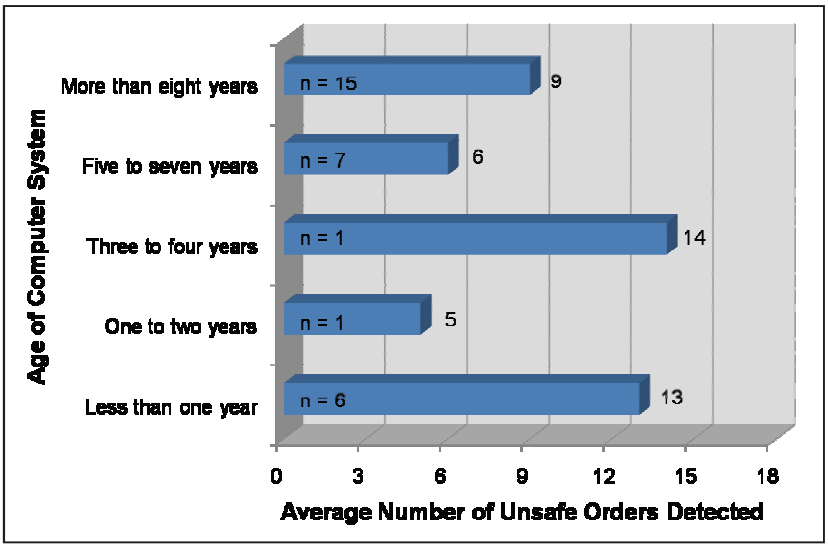

Figure 3. Average Number of Unsafe Orders Detected by Age of Pharmacy Computer System (n is the number of facilities)

Information about specific vendors' computer system and drug information providers was not collected in the PA-PSRS Workgroup on Pharmacy Computer System Safety. While the vendor software and drug information provider content play a role in pharmacy computer system performance, how each hospital installs, implements, updates, and interfaces their computer system is potentially more crucial in effective performance. In a similar field test in 1999, ISMP analyzed vendor and drug information provider products separately and found that no computer system or drug information provider was better than another at detecting unsafe orders. Each had significant limitations similar to those listed above.

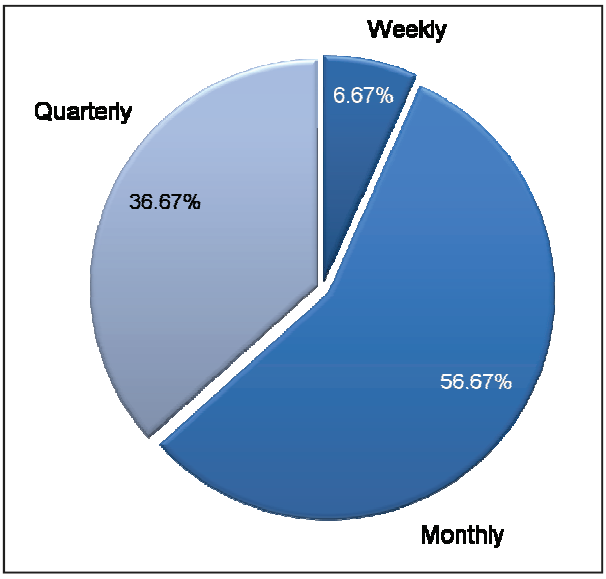

Figure 4. Frequency of Drug Information Updates. Note: there were no hospitals that updated their drug information content only twice per year or less often.

Also, respondents at different sites using the same vendor's computer system and/or drug information provider reported considerable variation in the ability to detect unsafe orders. It was concluded that this was likely due to differing system applications, variations in maximizing system capabilities, and varying frequency of receiving and integrating drug information updates.[2]

Conclusion

While pharmacy computer systems increase staff efficiency and support effective drug therapy monitoring, the PA-PSRS Workgroup on Pharmacy Computer System Safety shows that pharmacists cannot rely on this tool alone to detect potentially harmful medication errors.

Overall, results were mixed when comparing the performance of systems among workgroup participants with the results of similar field tests conducted by ISMP in 2005 and 1999. Pennsylvania hospitals' pharmacy computer systems did perform slightly better intercepting some unsafe orders. Also, hospital pharmacies updated the drug information content of their computer systems more frequently. However, hospital pharmacy computer systems continue to allow users to override serious warnings.

We encourage other Pennsylvania facilities to test their pharmacy computer systems. If your system is not performing as well as you would like, work with your pharmacy, hospital information technology personnel, and pharmacy computer system vendor to

address problems proactively to prevent future errors. Maximize your systems' capabilities whenever possible by responding to serious error-prone situations reported in the *PA-PSRS Patient Safety*

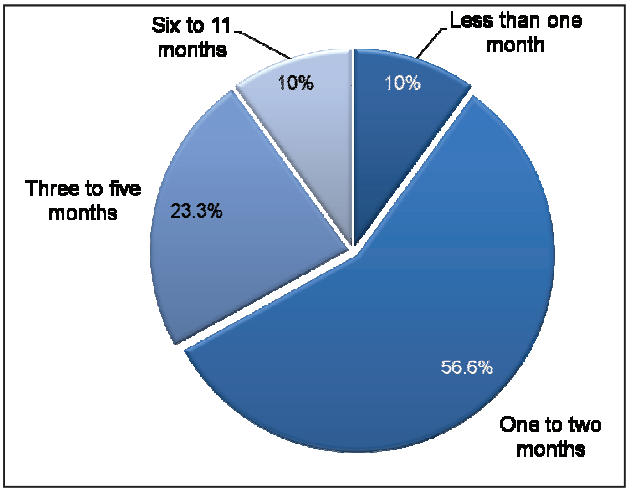

Figure 5. Time to Update Pharmacy Computer System with Important New FDA Drug Interactions. Note: there were no hospitals that require a year or more to update their pharmacy computer system with important new FDA drug interactions.

Advisory and other safety publications. Also, consider participating in the Leapfrog Group's Simulator, expected to be released in 2007, and test your computerized prescriber order entry (CPOE) systems for their safety performance.

We thank all who participated in the PA-PSRS Workgroup on Pharmacy Computer Safety. (Pennsylvania facilities can obtain a copy of the survey worksheet by contacting PA-PSRS helpdesk at support_papsrs@state.pa.us.) We plan to use the results to continue efforts to promote improved pharmacy computer technology for more effective recognition of clinically significant drug errors.

Notes

1. Institute for Safe Medication Practices. Safety still compromised by computer weaknesses: comparing 1999 and 2005 pharmacy computer field test results. *ISMP Medication Safety Alert! Acute Care Edition*. 2005 Aug 25;10(17):1-6.
2. Institute for Safe Medication Practices. Over-reliance on pharmacy computer systems may place patients at great risk. *ISMP Medication Safety Alert! Acute Care Edition*. 1999 Feb 10;4(3):1-2.

Resources Associated with *PA-PSRS Patient Safety Advisory* Articles

The Patient Safety Authority publishes additional information on its Web site (http://www.psa.state.pa.us) related to *PA-PSRS Patient Safety Advisory* articles, including posters (see the verbal orders poster example at right), toolkits, brochures, and other materials.

Advisory articles that have yielded such materials include the following:

- "Contrast-Induced Nephropathy: Can This Iatrogenic Complication of Iodinated Contrast be Prevented?" (March 30, 2007, Vol. 4, Suppl. 1)
- "Airway Fires during Surgery" (March 2007, Vol. 4, No. 1)
- "Bone Cement Implantation Syndrome" (December 2006, Vol. 3, No. 4)
- "I'm Stuck and I Can't Get Out! Hospital Bed Entrapment" (December 2006, Vol. 3, No. 4)
- "Skin Tears—The Clinical Challenge" (September 2006, Vol. 3, No. 3)
- "Use of Color-Coded Wristbands Creates Unnecessary Risk" (December 2005, Vol. 2, Suppl. 2)
- "Improving the Safety of Telephone or Verbal Orders" (June 2005, Vol. 3, No. 2)

To view or download any of the resources, click on "Advisories and Related Resources" in the left-hand column of the Authority's home page. Then, click on "Resources Associated with Patient Safety Articles."

An Independent Agency of the Commonwealth of Pennsylvania

The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error ("Mcare") Act. Consistent with Act 13, ECRI Institute, as contractor for the PA-PSRS program, is issuing this publication to advise medical facilities of immediate changes that can be instituted to reduce Serious Events and Incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority's Web site at www.psa.state.pa.us.

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The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP's efforts are built on a non-punitive approach and systems-based solutions.