PA PSRS
Pennsylvania Patient Safety Reporting System

Patient Safety Advisory

Produced by ECRI & ISMP under contract to the Patient Safety Authority Vol. 3, No. 2—June 2006

Implementing Change Through PA-PSRS

Since statewide mandatory reporting of adverse events and near-misses was initiated two years ago, we have repeatedly stressed that the purpose of the PA-PSRS system is not merely to submit reports into a bottomless data pit but to use those reports as a learning resource. That's the rationale behind the publication of the *Patient Safety Advisory.*

Because individual *Advisory* articles suggest clinical protocols you can implement to prevent a reoccurrence of a similar event in your facility, it is your responsibility to disseminate this information to both policy makers and frontline providers. After all, real improvement in patient care will not occur unless facilities are willing to take the necessary steps to change routines that may be compromising patient safety.

Nearly 75% of hospitals responding to our last user survey said they have implemented changes as a result of information contained in *Advisory* articles. This statistic is consistent with other findings that credit Act 13 with enhancing patient safety within Pennsylvania's healthcare facilities. In fact, at least 80% of healthcare executives surveyed said they believe the culture of safety has improved in their facility since the implementation of Act 13.

Facilities frequently provide feedback about how they respond to individual *Advisory* articles. Sometimes they write to describe a similar incident or to share the results of a root cause analysis. In other cases they explain protocols they previously implemented to prevent such an event from happening. For example, in response to an article on fires associated with alcohol-based solutions, one facility introduced protocols to catch alcohol runoff in the operating room, while a second hospital eliminated the use of alcohol-based hair products by patients. In

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Improving the Safety of Telephone or Verbal Orders

Verbal orders—those that are spoken aloud in person or by telephone—offer more room for error than orders that are written or sent electronically. Interpreting speech is inherently problematic because of different accents, dialects, and pronunciations. Background noise, interruptions, and unfamiliar drug names and terminology often compound the problem. Once received, a verbal order must be transcribed as a written order, which adds complexity and risk to the ordering process. The only real record of a verbal order is in the memories of those involved.

When the recipient records a verbal order, the prescriber assumes that the recipient understood correctly. No one except the prescriber, however, can verify that the recipient heard the message correctly. If a nurse receives a verbal order and subsequently calls it to the pharmacy, there is even more room for error. The pharmacist must rely on the accuracy of the nurse's written transcription of the order and the pronunciation when it is read to the pharmacist. Sound-alike drug names also affect the accuracy of verbal orders. There have been numerous reports submitted to PA-PSRS in which drug name pairs have been misheard.

For example:

1. A misheard verbal order led to a patient's receiving erythromycin instead of azithromycin.

2. A nurse mistook a verbal order for Klonopin 0.1 mg when the intended medication was clonidine 0.1 mg.

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PA-PSRS Patient Safety Advisory (ISSN 1552-8596) is published quarterly, with periodic supplements, by the Pennsylvania Patient Safety Authority. This publication is produced by ECRI & ISMP under contract to the Authority as part of the Pennsylvania Patient Safety Reporting System (PA-PSRS).

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Office Location: 539 Forum Building
Harrisburg, PA 17120
Mailing Address: P.O. Box 8410
Harrisburg, PA 17105-8410
Telephone: 717-346-0469
Facsimile: 717-346-1090
Web site: www.psa.state.pa.us
E-mail: patientsafetyauthority@state.pa.us

Implementing Change Through PA-PSRS (Continued)

response to articles citing the importance, if not the necessity, of "time-out" prior to surgery—which remains a continuing problem despite both JCAHO requirements and common sense—another hospital implemented educational programs specifically targeted to surgeons in order to achieve full buy-in for time-out protocols from its physician community.

Perhaps no article has generated as much interest and feedback as the December 2005 *Supplementary Advisory* on risks associated with color-coded wristbands. Within days of publication, we heard from patient safety officers at numerous Pennsylvania hospitals and ambulatory surgical facilities, as well as from government officials, health policy makers, and hospital association executives from other states and countries.

Earlier this year, patient safety managers at Allied Services in Scranton helped facilitate a regional task force to approach this problem head-on. Representatives from numerous hospitals and healthcare facilities in Lackawanna County initiated an ongoing workgroup to develop common policies for the use of color-coded wristbands in their institutions and to outline implementation and education plans. Participation has expanded to include facilities in Monroe, Wyoming, Wayne, Luzerne and Cumberland counties. By reaching consensus, workgroup members are demonstrating a shared vision to promote safe practices for their patients, even among traditionally "competing" institutions. As word of their success spreads, similar workgroups are convening in other counties and regions as well. A forthcoming *Patient Safety Advisory* will be devoted to this robust, and grassroots, initiative. In the meantime, if you would like more information about the workgroup, you can contact Bonnie Haluska at bhalus@allied-services.org.

Interestingly, the event that generated the original *Advisory* article on color-coded wristbands was based on one incident in one hospital. While this demonstrates the value of near-miss reporting, it really demonstrates the value of sharing best practices with one another. As I noted at the outset, that's the purpose of these *Advisories*. And that's why I am again asking you to please share your experiences with us so we, in turn, can share the lessons you have learned with others.

Alan B.K. Rabinowitz
Administrator
Patient Safety Authority

Acknowledgements

The PA-PSRS staff would like to thank the following individuals, who graciously offered us their insight and/or reviewed selected articles prior to publication:

Helen King, Director of Clinical Operations/Director of Nursing, Saint Vincent Surgery Center of Erie

Alison Lavery, MA, Risk Manager, Fairmount Behavioral Health System

Karen Loeffler, Director Safety/Risk Management, Memorial Medical Center

James McNamara, Legal Counsel, Saint Vincent Health System

Jeffrey Oliver, RRT/RPFT, Lead Therapist, Excela Health, Latrobe Campus

Denise Weisbrodt, RN, Director, Clinical Risk Management, Memorial Medical Center

Improving the Safety of Telephone or Verbal Orders (Continued)

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3. A telephone order relayed to pharmacy by a nurse for "Viscerol" was clarified by pharmacy as Vistaril.

Drug names are not the only information prone to misinterpretation. Numbers are also easily misheard. Examples of this type of error reported to PA-PSRS include:

1. A phone order mistaken for Toradol 50 mg was administered prior to the pharmacy review, when the intended dose was 15 mg.

2. A patient told a doctor that she regularly took five 30 mg phenobarbital tablets at bedtime, and the doctor wrote for 530 mg of phenobarbital. When the pharmacist called to clarify, the physician changed the order to 150 mg.

3. An emergency room nurse thought the physician stated that a patient was to receive "1 and 1/2 teaspoons" of Zithromax, which was given. In checking the written order, the dose was noted for 1/2 teaspoon.

Similar cases have also been reported to the Institute for Safe Medication Practices (ISMP). In one example, an emergency room physician verbally ordered "morphine 2 mg IV," but the nurse heard "morphine 10 mg IV." The patient received a 10 mg injection and developed respiratory arrest. In another case, a physician called in an order for "15 mg" of hydralazine to be given IV every 2 hours. The nurse, thinking that he had said "50 mg," administered an overdose to the patient who developed tachycardia and had a significant drop in blood pressure.[1]

Communicating multiple medications verbally at the same time also increases the opportunity for error. ISMP has reported on a case in which a premature baby girl developed respiratory problems shortly after birth. Plans were made to transfer her to a NICU at a nearby children's hospital. While awaiting transfer, the physician gave a verbal order to administer ampicillin 200 mg and gentamicin 5 mg IV push. The nurse misheard the second antibiotic order as gentamicin 500 mg. The pharmacy was closed, so a nursing supervisor obtained seven vials of an adult concentration of gentamicin (80 mg/2 mL vials) from a night cabinet. The pediatric concentration (20 mg/2 mL vials) also was available in the same night cabinet, but the nursing supervisor never noticed it. She brought the gentamicin to the patient care unit, where one nurse drew up 12.5 mL of medication from the seven vials, and another nurse gave the medication IV push to the infant. The error was discovered when the ambulance crew from the children's hospital arrived and asked what the infant had been given. Before the infant was transferred, her gentamicin level was 590 mcg/mL. After transfer, levels declined steadily over the next several days, and renal function continued to be normal.[2]

Medication errors can also occur when communicating a patient's lab values verbally. In reports submitted to PA-PSRS, many of these types of errors involved misinterpretation of blood sugar levels for patients on insulin therapy.

Examples include:

1. A nursing assistant verbally told a nurse the results of a patient's Accu-check results. The nurse misinterpreted what she was told and based insulin coverage on a falsely high blood sugar, so the patient received 4 units insulin when they should not have received any insulin.

2. A patient was given 10 units of regular insulin based on blood sugar verbally reported to be 353. The patient's blood sugar was 85.

3. A nurse thought that the nursing student stated the patient's blood sugar as 257 when it was 157. The patient was given 6 units regular insulin instead of 2 units regular insulin.

Another significant problem that arises with the use of verbal orders are breakdowns in the communication of relevant patient information, such as the current medication list, diagnoses, or comorbid conditions and allergies. When medications are ordered verbally and the normal pharmacy check systems are not in place (such as when medications are available in unit stock, or when pharmacy is closed but accessible by non-pharmacy staff), more issues can arise, as evident in this case reported to PA-PSRS:

Physicians can receive continuing medical education (CME) credits for completing the self-assessment questions related to this article. See page 27 for details.

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Improving the Safety of Telephone or Verbal Orders (Continued)

A nurse received a verbal order from a physician for Zosyn. The patient had a documented allergy to penicillin, and both the physician and nurse were unaware that Zosyn is contraindicated for this patient. The pharmacy staff was gone for the day, and medication was obtained from the pharmacy after hours from the night cabinet. Two doses were administered to the patient with no ill effect or adverse reaction. The following day, the pharmacy notified nursing that Zosyn was derivative of penicillin, and the medication was discontinued.

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) recently added a National Patient Safety Goal to address the error-prone procedure of verbal orders. The goal states that the receiver of the verbal or telephone order should **write down** the complete order or enter it into a computer, then **read it back**, and receive **confirmation** from the individual who gave the order or test result.[3]

Reports submitted to PA-PSRS include errors that could have been prevented if this technique had been used. For example:

A nurse gave a medication upon receipt of a verbal order from a physician. The nurse did not write the verbal order into chart first. The nurse administered the medication, guaifenesin with codeine, then read what the physician had written later in the chart. The physician wrote the order for Phenergan VC with codeine.

A nurse received a verbal order from a physician but did not write the order in the chart. When the medication came from pharmacy, she assumed it was for her patient. The patient was given one bottle of phospho-soda bowel prep, which belonged to another patient. The patient who received the solution did not have an order for the phospho-soda or a colonoscopy.

Visit the Patient Safety Authority website for a "Verbal Orders Toolkit" that includes:

- A single-topic reprint of this article, which can be downloaded and easily e-mailed to colleagues.
- A poster to remind clinicians about the read-back procedure.
- A sample policy on verbal orders based on the guidance in this article.
- A copy of the survey presented in Table 2 in Microsoft Word format, which can be downloaded and edited to customize it for your facility.
- A brief, self-running Microsoft PowerPoint slideshow with audio narration on safe practices related to verbal orders, which can be downloaded and shown to frontline caregivers.

Physicians at Cincinnati Children's Hospital Medical Center recently studied error rates with and without the use of read-back of orders given verbally and then entered into the computerized prescriber order entry system. In the Cincinnati facility, the attending physician or chief resident typically communicates orders verbally during rounds, and a resident physician then enters them into the computer system at a bedside terminal. In the first part of the study, the team on rounds accepted 70 consecutive oral orders and entered them into the computer. After rounds, they examined the orders and found a 9.1% error rate, mostly in drug dosages that would not have affected patient safety. However, in two instances, the resident ordered the wrong drug. In the second part of the study, before leaving a patient's room, the resident read back the order entered into the computer. The attending physician or chief resident then verified its accuracy. **The researchers examined 75 orders and found that the error rate dropped from 9.1% to zero.** The process added only seconds to each visit to a patient's room, so it did not slow down physician rounding.[4]

Safe Practices

Faxes, electronic mail, and point-of-care computerized prescriber order entry are reducing the need for verbal orders in non-emergent situations. However, it is very unlikely that they will ever be totally eliminated. Sharing the following safe practices with nurses, pharmacists, and physicians in your facility may help to stimulate discussion. While all of these suggestions may not be feasible in every organization, they can help you to evaluate your current practices.

Safe practices include:

- Limiting verbal communication of prescription or medication orders to urgent situations in which immediate written or electronic communication is not feasible. For

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Improving the Safety of Telephone or Verbal Orders (Continued)

example, verbal orders can be disallowed when the prescriber is present and the patient's chart is available. Verbal orders can be restricted to situations where it is difficult or impossible for hard copy or electronic order transmission, such as during a sterile procedure.

- For prescribers, enunciating verbal orders clearly. For order recipients, writing down the complete order or entering it into a computer, reading it back, and receiving confirmation from the individual who gave the order. In a safe environment, these steps are treated as essential and become habit even when the recipient is confident they understood the order correctly. As an extra check, either the prescriber or listener can spell unfamiliar drug names, using "D as in David," "B as in Bravo," and so forth. Pronouncing each numerical digit separately can also help avoid confusion—saying, for example, "one six" instead of "sixteen" which is often heard as "sixty."

- For all medication orders, including the purpose of the drug to ensure that the order makes sense in the context of the patient's condition. Most reported sound-alike name pairs have different indications.

- Including the mg/kg dose along with the patient's specific dose for all verbal neonatal/pediatric medication orders.

- For prescribers, asking for important patient information such as drug allergies, lab values and diagnosis or comorbid conditions that may effect the prescribed medication(s).

- Expressing doses of medications by unit of weight (e.g., mg, g, mEq, mMol). Verbal orders that specify the dose in terms of the number of tablets, ampuls, or vials, and orders that state a volume without also expressing the concentration, have led to errors and even serious patient injury because many medications are often available in several package sizes and strengths.

- Having a second person listen to a verbal order whenever possible. Students or other inexperienced staff may require special supervision when handling verbal orders.

- Recording the verbal order directly onto an order sheet in the patient's chart. Transcription from scrap paper to the chart introduces another opportunity for error. Phone or pager numbers can be helpful in case it is necessary for follow-up questions.

- Recipients of verbal orders can be required to sign, date, time, and note the order according to prescribed procedures. Prescribers can be mandated to verify and sign/date orders within a predetermined time frame.

- Disallowing verbal orders for chemotherapy because of their complexity and potential for tragic errors.

- Disallowing medication requests from nursing units to the pharmacy unless the verbal order has been transcribed onto an order form and simultaneously faxed or otherwise seen by a pharmacist before the medication is dispensed.

- Limiting verbal orders to formulary drugs. The names of drugs unfamiliar to staff are more likely to be misheard and their uses and dosages may be less familiar.

Table 1. Checklist for Policies and Procedures Related to Verbal Orders

Do your facility's policies and procedures:

- Describe limitations or prohibitions on the use of verbal orders?
- Provide a mechanism for the recipient to ensure validity/authenticity of the prescriber?
- List the required elements of a complete verbal order?
- Describe situations in which verbal orders may or may not be used?
- List and define the individuals who may send and receive verbal orders?
- Provide guidelines for clear and effective communication of verbal orders?

Source: Adapted from the National Coordinating Council for Medication Error Reporting and Prevention.[6]

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Improving the Safety of Telephone or Verbal Orders (Continued)

Table 2. Sample Assessment Questionnaire on Verbal Orders

This questionnaire is intended to measure awareness of, understanding of, and adherence to facility policies and procedures regarding verbal orders. This presumes that the facility already has such policies and/or procedures, or that there is an established cultural norm that governs how such orders are given, received, and implemented.

The questionnaire is intended to be answered by physicians, nurses, pharmacists, allied health practitioners, or any other individuals who may be involved in giving, receiving, relaying, or acting on verbal orders. "Correct" or desired answers are not identified because these may vary among different organizations or healthcare settings.

Before administering the questionnaire, determine whether all the questions make sense in the context of the unique characteristics of your facility. Consider whether any questions should be added, deleted, or revised. When analyzing the results, try comparing the responses from different groups of providers (e.g., physicians, nurses, pharmacists).

1	How familiar are you with our policies and procedures concerning verbal orders?	Very Familiar 5	4	Somewhat familiar 3	2	Not at all familiar 1
2	When taking a verbal or telephone order, how often does the recipient read back the order to the prescriber?	Always 5	4	Sometimes 3	2	Never 1
3	When giving verbal orders, how often do prescribers state each digit separately (e.g., saying "one, six" instead of "sixteen")?	Always 5	4	Sometimes 3	2	Never 1
4	Indicate your level of agreement with this statement: "Verbal or telephone orders are given only in emergency situations or when written orders are not possible (e.g., during a sterile procedure)."	Strongly agree 5	Somewhat agree 4	Neither agree nor disagree 3	Somewhat disagree 2	Strongly disagree 1
5.	When prescribers give verbal orders for medications, how often do they include the indication for the medication?	Always 5	4	Sometimes 3	2	Never 1
6.	Indicate your level of agreement with this statement: "I have personally witnessed or been involved in a case where a patient was injured or could have been injured because a verbal or telephone order was misinterpreted."	Strongly agree 5	Somewhat agree 4	Neither agree nor disagree 3	Somewhat disagree 2	Strongly disagree 1

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Improving the Safety of Telephone or Verbal Orders (Continued)

- Limiting the number of personnel who may receive telephone orders to help ensure familiarity with facility guidelines and the ability to recognize the caller, which reduces the potential for fraudulent telephone orders.[1]

- Whenever possible, having a pharmacist receive verbal orders for medications and ensuring a mechanism for pharmacists to transcribe the orders directly into the medical record.

- Raising awareness of problematic drug name pairs at your facility based on your reports submitted to PA-PSRS so that practitioners can be prepared to challenge questionable orders as they are received.[5]

Tools for the Patient Safety Officer

Here are three things the Patient Safety Officer can do to improve the medication safety process with respect to verbal orders.

1. First, determine whether your facility's policies and procedures address verbal orders. If this topic is not addressed, consider adding it to existing policies and procedures, or develop new ones focused on this issue.

2. If you already have relevant policies and procedures in place, you can use the elements in Table 1 as a checklist to identify any potential gaps or room for improvement.

3. If your policies and procedures already address all the elements of a safe environment with respect to verbal orders, how closely are clinicians adhering to those principles? Table 2 presents a brief questionnaire you can adapt and administer quickly to gauge clinical staff's understanding of and adherence to the safe practices your facility has adopted.

Notes

1. Institute for Safe Medication Practices (ISMP). Instilling a measure of safety into those "whispering down the lane" verbal orders. *Medication Safety Alert! 24 Jan,* 2001; 6(2):1-2.

2. ISMP. Verbal order spells near disaster. *Medication Safety Alert! 4 Sept,* 2002; 7(18):2.

3. JCAHO. National Patient Safety Goals. [cited 2006.] Available from Internet: http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/06_npsg_facts.htm

4. Vossmeyer MT. Improving patient safety using a verbal order read back process. Pediatric Academic Societies Annual Meeting; 2006 Apr 29; San Francisco (CA).

5. ISMP. Instilling a measure of safety into telephone and verbal orders. *Medication Safety Alert! Community/Ambulatory Edition.* 2003;2(6):2-3.

6. National Coordinating Council for Medication Error Reporting [cited 2006 Feb 24.] Available from Internet: http://www.nccmerp.org/council/council2001-02-20.html

Abbreviation "Gotchas"

PA-PSRS reports abound with occurrences involving misunderstanding of abbreviations. While many of these confusing abbreviations are related to medication orders, these recent examples don't involve medications:

An order indicated, "KUB/CX OBST SERIES." The physician intended this to mean to cancel (CX) the kidneys/ureters/bladder (KUB) series and to perform an Obstruction (OBST) Series. The X-ray Technician misinterpreted the CX. The patient received a chest X-ray (commonly abbreviated as CXR).

A physician ordered "SDP," intending the patient to receive Single Donor Platelets. In Blood Bank, however, SDP is an abbreviation for Solvent/Detergent-treated Plasma, which is what was given to the patient.

A chart notation indicated UH (umbilical hernia) repair, which the surgical resident misinterpreted as LIH (left inguinal hernia) repair. The resident marked the patient's left inguinal area. Fortunately, the site marking error was discovered by the attending surgeon prior to the procedure.

You may want to consider adding these abbreviations to your Do Not Use abbreviation list. Also, a multidisciplinary evaluation of facility abbreviations may reveal that a given abbreviation might have different meanings in different departments. Identical/similar abbreviations for diagnostic tests may be identified if the facility evaluates its computerized order entry screens.

Have you identified other abbreviations that have been open to misinterpretation or have multiple interpretations? If so, let us know by e-mailing your experience to PA-PSRS at Support_papsrs@state.pa.us.

We'll place these abbreviations in the Abbreviations "Gotchas" box in future issues.

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Mishaps Involving In-Line or Closed System Suction Catheters

Several PA-PSRS reports indicate problems with in-line suction catheters—also called closed system suctioning (CSS). The reports suggest errors in catheter selection or misconnection with other tubing. In either case, patient care can be compromised, though in these cases permanent injury was averted.

Patient with tracheostomy was found to have the incorrect in-line suction system. The endotracheal tube in-line suction catheter was attached to the tracheostomy. Error was immediately corrected.

An incorrect in-line catheter was applied to the patient's tracheostomy by respiratory therapist to help control secretions. The patient experienced respiratory distress within approximately 20 minutes. Respiratory therapist was called to see the patient again and realized what had happened. The catheter used would not allow the patient to exhale. This was recognized and the patient was bagged, arterial blood gases were done immediately (CO_2 133, PH 7.089). The patient was transferred to the ICU and placed on a ventilator. Blood gases normalized within 90 minutes. The patient was removed from the ventilator the following day.

The child's nasogastric feeding was connected to the in-line suction port. Within a minute the nurse realized the error. The patient had a brief oxygen desaturation to 88%. There was 1.5 cc of the feeding in the port and this was removed by suctioning. The in-line suctioning device was changed. The child's oxygen saturation returned to 100%. A chest x-ray was done.

Patient found attached incorrectly to in-line suction. Aerosol tubing was attached to the T-piece with the blue cap on the opposite end of the T-piece. This did not allow the patient to exhale properly. Excess flow from the aerosol had no place to drain. Cuff was deflated at the time. Patient experienced tachypnia and diaphoresis but was also febrile. No desaturation occurred.

In-line suction catheters are used to remove airway secretions. This method of tracheal suctioning was first developed in the late 1970's by a respiratory care practitioner.[1] "The closed suctioning technique is currently used in the majority of ICUs in the United States and is considered safer and more cost-effective than traditional open-suctioning systems."[1]

CSS reduces the patient's risk of infection and protects the caregiver from exposure to the patient's secretions. Unless the catheter becomes soiled or malfunctions, CSS can be used for 24 to 72 hours depending on the model.[2] The catheter is maintained within a clear plastic sleeve and is rinsed between use with sterile saline.

Catheter Selection Problems

Two events were reported by the same institution in which the wrong types of catheters were used. In one case an in-line suction catheter for patients with endotracheal tubes (ETT) was used for patients with tracheostomy tubes. In the other case, the mix-up was between in-line suction catheters for tracheostomy patients receiving ventilator support and those for tracheostomy patients not receiving ventilator support.

Following the second report, the reporting organization shared the details of the situation and sent to PA-PSRS the samples of the two types of catheters that were confused possibly because of look-alike packaging (see Figure 1).

Knowledge Deficit

Proper education on patient suctioning includes technique and product selection. Catheters used in an ETT are longer to accommodate for the oral and pharyngeal space before reaching the trachea. Catheters used for a patient with a tracheostomy tube are shorter as the trachea is entered directly.

Catheter length was not the problem in the second case, which occurred on a medical/surgical unit. If ventilated patients were not routinely managed on this unit, the staff may not have recognized the difference between the catheter types. Both in-line catheters are for patients with a tracheostomy. However, one type is used for mechanically ventilated patients, while the other is for patients who are not mechanically ventilated.

In each of these cases, the expert team members responded with immediate action to correct the error and address patient needs.

Look-Alike Packaging

A potential contributing factor may be look-alike packaging. The packaging for the two tracheosotomy catheters is very similar and colored similarly.

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Mishaps Involving In-Line or Closed System Suction Catheters (Continued)

PA-PSRS has reported on incidents in which look-alike packaging contributed to patient safety hazards.[3,4] While that seems to be the case here, we do not believe the problem of poorly differentiated packaging is limited to the brand shown in Figure 1. Other manufacturers' lines also poorly distinguish between types of suction catheters.

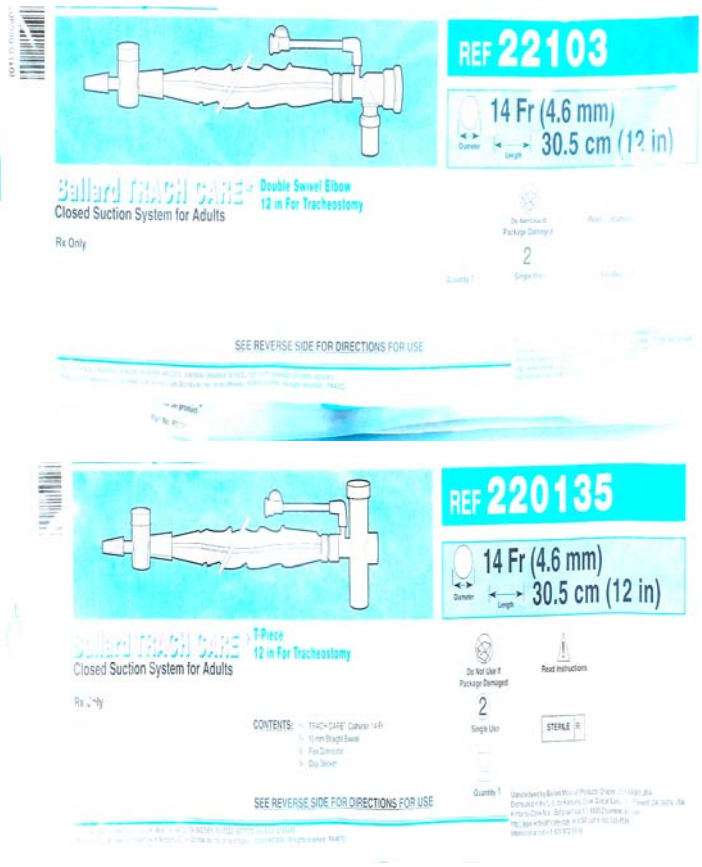

Figure 1. Poorly Differentiated Packaging May Contribute to Errors in Catheter Selection

Strategies that may help to minimize product selection errors include:

- Teaching staff responsible for patient suctioning about catheter selection, emphasizing the differences between specific types of catheters and the consequences of choosing the wrong catheter.
- Using bold print on storage bins to alert staff to differences between products.
- Providing helpful hints to facilitate early recognition of selection errors. For instance, informing staff that endotracheal catheter length is greater than the tracheostomy catheter length and that the ventilator tracheostomy catheter has a flexible connector to attach to the ventilator circuit.
- Encouraging team assessment as a "safety net" to ensure early identification of errors.
- Using an alternate vendor for one of the products when items have dangerously similar packaging.[5,6]
- Notifying staff when two products have similar packaging.
- Engaging staff in identifying look-alike packaging and encouraging reporting of situations in which such packaging is noted.
- Storing look-alike items away from each other and keeping them on separate shelves.
- Labeling the package with a colored dot or other mark to catch the eye of the user.
- Displaying a poster board alerting staff to look-alike packages (for example, indicating the difference between the packaging of catheters for use with patients on ventilator support and that of catheters for patients who do not require a ventilator).[5,7]
- Assessing all packages that come into the facility for similarity with other packages already stored.[5,6]
- Reporting problems to ensure that attention is brought to the identified problem and lessons learned are shared.[5]

Tubing Misconnections

PA-PSRS has received two reports in which CSS catheters were inadvertently misconnected. In one, the in-line suctioning was attached briefly to a feeding tube. In the other, the aerosol tubing obstructed the patient's ability to exhale.

Recently published guidance from ECRI[8] on preventing misconnections emphasizes taking extra precautions to minimize the risk of inadvertent misconnection by:

- Tracing lines to their source prior to making connections.
- Increasing lighting to improve visualization.

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Mishaps Involving In-Line or Closed System Suction Catheters (Continued)

- Revising policies to include positioning of specific lines on different sides of the patient.
- Educating staff on the risks of using adapters or force fitting connections.
- Reporting all misconnections even when no injury or harm is caused.

A proactive approach that organizations can take to address misconnections is to conduct a pre-purchase evaluation which allows clinicians the opportunity to work with equipment and uncover any real or potential misconnection possibilities.[8]

Conclusion

There are many possible reasons for these CSS catheter mishaps such as knowledge deficits, failure to follow the protocol, lack of familiarity with available equipment and supplies, work overload, distraction, and fatigue. The most important step in addressing events of this nature is to get to the root of the error and address the causative factors. The best solution is to eliminate the potential for these mishaps between various medical tubings and to learn from past mistakes while continuing to support staff in performing their daily activities.

Notes

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Non-Radiopaque Sponges in the Operating Room: How One Department Can Affect Another

Editor's Note: PA-PSRS received the following case study from the Patient Safety Officer (PSO) at a hospital in eastern Pennsylvania. While the hospital did not wish to be identified, they did wish to share the results of their analysis of the case and the lessons they learned from it. Other PSOs might consider sharing this case with their own OR and Interventional Radiology personnel.

We would like to share with others a lesson learned from an event that occurred in our main operating room (OR) suite. An elderly patient was to have an endovascular repair of an abdominal aortic/bilateral iliac aneurysm. The procedure was performed by an interventional radiologist in concert with a general surgeon for the initial cut down and standby in the event of any complication.

The patient was brought to the operating room and properly identified. The OR team performed their cut down procedure with appropriate counts of instrument and Raytec sponges. Upon completion, the OR team stepped aside, but remained in the room, to allow the Interventional Radiology (IR) team to proceed with their part of the case.

As the IR part of the case proceeded, an OR scrub nurse noticed that Versalon sponges (non-radiopaque) had been added to the field. The scrub nurse immediately asked for a sponge count before proceeding. While the count revealed nine (9) sponges, the box was marked ten (10) sponges. Everything in the room was double checked for the missing sponge to no avail. The tenth sponge was never accounted for, and being non-radiopaque, it could not be detected by x-ray. The sponges were only used in the femoral cut down area, which was examined by both the surgeon and the interventional radiologist. However, non-radiopaque sponges should never be present in an OR.

Post-operatively, the OR Director met with the Radiology Director and ascertained that the IR team had brought the Versalon sponges into the OR with their set-up. The sponges in the IR room in Radiology were all non-radiopaque.

Lesson learned: Radiology now uses all radiopaque sponges for IR and no longer brings their own set-up into the OR. This episode made all involved think before they enter another area of the hospital of the impact we have on each other.

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Hydrofluoric Acid Exposure—A Double Whammy That's Not Just Skin Deep

The following report was submitted to PA-PSRS.

A patient came to the Emergency Department complaining of chest pains. He also stated he received an acid burn of the hand prior to his arrival. The ED physician assessed the hand and found it unremarkable. The next day, however, the patient's hand was noted to have 3+ edema. Two fingertips and underneath four fingernails were black. Poison Control was contacted about an hour after this assessment, resulting in immediate treatment of the hand/digits with calcium gluconate gel. The patient was transferred to a burn unit for further treatment.

What happened here? Calcium gluconate gel is used to treat hydrofluoric acid (HF) burns. This report may reflect missed opportunities. The patient and the Emergency Department did not appreciate the severity of the HF exposure when the patient first presented to the ED. The ED did not contact Poison Control until the day after exposure when tissue damage was apparent, thus delaying appropriate treatment. Because of the unique characteristics of HF exposure, patients and physicians may not be aware of the damage such exposure can cause.

Hydrofluoric Acid

HF is an inorganic acid that is ubiquitous in many industries such as electronics/semiconductor manufacturing, oil refineries, electroplating, rock/mineral analysis.[1-3] It synthesizes fluorine-containing compounds such as Teflon[1,2] arrests fermentation in brewing,[4] and etches glass.[5] Sixty percent of HF is used to manufacture refrigerants such as Freon.[4]

Several household products contain dilute HF as well, including: aerosol propellants, fire extinguishers, home rust removers, fluorescent lights, and automobile mag/wire wheel cleaners.[2,6-9] Consumers can purchase HF-containing products in stores and via the Internet,[6,10,11] but consumer product labels may not specify the injuries caused by HF exposure and the need for immediate treatment when exposure occurs. Because consumers do not recognize the danger of HF-containing products, they may not wear protective equipment as specified on the labels.[12]

Symptoms/Onset

The severity and onset of symptoms related to HF exposure vary according to the concentration and volume of HF, the length of exposure, the exposure route, the penetrability of exposed tissue, the body surface area exposed, and the extent to which preventive/protective measures were used.[2,13,14] For example, severe burns, systemic toxicity, and life threatening electrolyte imbalances may occur with the following HF concentrations and body surface areas.[3,6,15,16]

HF Concentration	Body Surface Area
50% or stronger	1% or more (size of the sole of a foot)
Any concentration	5% or more
60% or stronger	inhalation

The onset of symptoms also varies with the HF concentration:[14,17,18]

HF Concentration	Onset of symptoms
Greater than 50%	Immediately
20-50%	1-8 hours
Less than 20%	Delay up to 24 hours

Table 1 displays the variety of symptoms according to route of exposure.

Table 1. Toxidrome for HF Exposure

Ingestion[20]
- Oral irritation
- Hypotension
- Nausea
- Vomiting
- Abdominal pain
- Chest pain
- Inability to swallow secretions
- Gastrointestinal changes
- Voice changes
- Respiratory distress

Pulmonary[8]
- Dyspnea
- Wheezing
- Hypoxia
- Respiratory failure
- Pulmonary edema

Laboratory abnormalities[8]
- Hypocalcemia
- Hypomagnsemia
- Hyperkalemia

Cardiac[5,8,19]
- Tachycardia
- Torsades de point
- EKG abnormalities
  - QRS complex widening
  - QT interval prolongation
  - Sinus tachycardia
  - Ventricular fibrillation

Neurologic/ Neuromuscular[5,8]
- Lethargy
- Loss of deep tendon reflexes
- Paralysis
- Carpopedal spasm
- Trousseau's sign
- Seizures
- Obtundation
- Respiratory depression
- CNS depression
- Tetany
- Muscle weakness
- Facial Spasm/ Chvosteck's sign

Physicians can receive continuing medical education (CME) credits for completing the self-assessment questions related to this article. See page 27 for details.

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Hydrofluoric Acid Exposure—A Double Whammy That's Not Just Skin Deep (Continued)

A toxidrome is a syndrome, or collection of symptoms, caused by a dangerous level of toxins in the body.[20] Table 1 presents the toxidrome for HF that indicates the need for aggressive emergency treatment.

While concentrated HF causes immediate pain and produces surface burns similar to other acids, exposure to dilute HF solutions can be particularly dangerous because the onset of tissue damage may be delayed.

The most common exposure is dermal, particularly the hands/digits.[3] For dilute exposures to the skin, the patient experiences severe pain that is out of proportion to the extent of tissue injury observed on initial assessment. This presentation should raise the suspicion that HF exposure has occurred.[3,21]

Pathophysiology

HF produces tissue damage via two mechanisms (hence, the double whammy). First, free hydrogen ions cause corrosive burns.[3,13,17,18,22] Second, fluoride ions penetrate the tissue and cause chemical burns by forming insoluble salts with calcium and magnesium in the body. Fluoride ions combine with other cations to make soluble salts that dissociate quickly. As a result fluoride ions are released again, causing further tissue destruction/necrosis (hence, exposure is not just skin deep).[3,13,17,18,22]

Unlike other acids which can be rapidly neutralized, the neutralization of HF may proceed for days during which tissue destruction may continue.[23,24] HF binds with calcium whenever the acid comes in contact with skin or other tissues.[23] Because calcium is required for cell life, fluoride's calcium-binding capacity may result in rapid cell death. Extensive HF exposure can inactivate large amounts of calcium in the body, significantly depleting calcium supplies required for vital bodily functions.[23]

If left untreated or undertreated, minor exposure may produce the same severe consequences as high-concentration HF burns. The delayed onset of symptoms may lull patients and medical caregivers into believing that the exposure did not cause harm, prolonging exposure and delaying treatment.[25] Moreover, deterioration can be precipitous – patients with minimal symptoms can progress to ventricular arrhythmia and even death within a matter of minutes after exposure to concentrated HF.[8]

Treatment

First aid and treatment for HF exposure can be quite involved and is beyond the scope of this article. Depending on the circumstances of the HF exposure, the goal is to deliver a pharmacologic antidote of calcium to the affected area:[3,26-29]

ROUTE OF EXPSURE	TECHNIQUE	PERCENT OF CALCIUM GLUCONATE
Dermal	Application of gel	2.5%
	Subcutaneous infiltration	5% or 10%
	IV or intra-arterial	10%
Ocular	Irrigation	1%
Inhalation	Nebulizer	2.5%
Ingestion	Oral and/or lavage	10%

The bottom line is that all HF exposures require medical evaluation and treatment regardless of whether first aid interventions were provided[15] or the size of the exposure.[1]

Resources

The following resources present detailed first aid, emergency responder, and medical interventions for HF exposure:

- Honeywell. Recommended medical treatment for hydrofluoric acid exposure [online]. 2000 May [cited 2005 May 5]. Available from Internet: http://membership.acs.org/F/FLUO/hfmedbook.pdf.
- Air Products and Chemicals, Inc. Safetygram #29:treatment protocol for hydrofluoric acid burns [online]. 2002 Aug [cited 2006 May 5]. Available from Internet: www.airproducts.com/Responsibility/EHS/ProductSafety/Product SafetyInformation/Safetygrams/safetygram29.pdf.
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- Dunser MW, Ohlbauer M, Reider J, et al. Critical care management of major hydrofluoric acid burns: a case report, review of the literature, and recommendations for therapy. *Burns* 2004 Jun;30(4):391-8.

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Hydrofluoric Acid Exposure—A Double Whammy That's Not Just Skin Deep (Continued)

- Kirkpatrick JJR, Burd DAR. An algorithmic approach to the treatment of hydrofluoric acid burns. *Burns* 1995;21(7):495-499.

Lessons Learned

While the PA-PSRS report highlighted above relates to HF exposure, implementing the following strategies will help to ensure more effective and timely interventions for any chemical exposure.

- Obtaining the following information when a patient presents to the ED with a chemical exposure:[3]
  - — Name of product, ingredients, concentration of chemicals
  - — Duration of exposure
  - — Any protective measures were used
  - — First aid interventions provided prior to ED presentation
  - — Medications/antidotes taken/applied
- If specific, written treatment protocols are not available at the treating facility, contacting Poison Control immediately so that appropriate and timely treatment is provided.
- Having treatment supplies[24,26] and treatment algorithms[30] readily available.
- Healthcare facilities, Poison Control, emergency responders, and communities can work together so that communication, education, drills, treatment supplies, and written protocols ensure coordinated and appropriate interventions to chemical exposures.

Notes

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Threat of Cornea Transplant Contamination

A report to PA-PSRS indicated that a facility had implanted a cornea that may have come from a donor with hepatitis B. Upon further investigation, the facility determined that the patient did not receive the cornea from that donor. The actual error was that the paperwork did not match the cornea. This incident prompted the organization to review its tissue procurement policy and procedure and become aware of the new JCAHO standards.

In another reported event, an implanted cornea tested positive for enterococcus on the transplant culture obtained at the time of surgery. However, few organisms were detected, and the cornea recipient was asymptomatic. Both the eye bank and the hospital concluded that the contamination probably occurred during specimen transfer.

A recently reported case resulted in endopthalmitis:

> *A patient who had a corneal transplant developed a case of endopthalmitis one day postoperatively. The patient was treated by a retinal specialist and did well. Two months postprocedure, the patient developed a lesion on the cornea and required corneal biopsy and cultures.*

These cases bring to attention the inherent risks associated with any transplant, whether it is an organ, a tissue, or a cornea. The patient, staff, physician, and receiving organization trust and have confidence that the transplant is safe for implantation as presented and that it has been obtained with the consent of the donor's next of kin. This trust was violated in the recently reported scandal in which implants were acquired illegally and with none of the medical safety practices in place.[1,2]

Efforts to protect the public from similar transplant issues have been initiated by the Eye Bank Association of America (EBAA), the American Academy of Ophthalmology (AAO), the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the U.S. Food and Drug Administration (FDA). The standards in place to protect patients undergoing corneal transplants are reviewed below.

Eye Banks

The first eye banks were established in the 1940s. In the following decades, eye banks flourished and the American Academy of Ophthalmology and Otolaryngology (which later separated into two organizations) recognized the need for standardization. In 1961, EBAA was established.[3,4] Eye banks remained self-regulated until 1993, when FDA oversight began.[3] Since 1998, Medicare has required hospitals to maintain a contractual relationship with organ procurement organizations and tissue and eye banks.[5]

Eye banks maintain operational standards for recovery, storage, evaluation, and distribution of corneal, scleral, and whole-globe tissue.[4] AAO's policy statement supports maintaining "current quality control efforts in eye banks" instead of imposing "more general standards and costly federal certification."[6] EBAA's medical standards provide both the operational and practice framework for a consistent level of quality. These standards have the approval of AAO's Eye Banking Committee and are discussed in this article.[7]

Corneas are the most commonly transplanted solid tissue.[3] In 2004, eye banks provided more than 51,500 corneas for keratoplasties.[6] The rate of cornea transplantation success (indicated when the recipient can read with vision of 20/50 or better) is greater than 90%.[4]

Cornea Procurement

The Association of periOperative Registered Nurses (AORN) recommends that tissue be procured in "clean, controlled environments, appropriate for sterile surgical procedures."[8] To minimize contamination, facilities consider traffic patterns when designating an area for procurement. The environment is cleaned according to AORN's "Recommended Practices for Environmental Cleaning in the Surgical Practice Setting."[8] In addition, clinicians wear surgical attire and use powder-free gloves and, when indicated, latex-free supplies.[8] EBAA accepts AORN's recommendations as an "acceptable standard for using aseptic technique during tissue procurement, processing and storage of ocular tissues."[7]

Corneas are sensitive tissue with an abbreviated window during which they can be retrieved.[4] Corneas can be retrieved using two methods: in situ corneoscleral rim excision, in which only the cornea is retrieved, or bilateral enucleation.[4,9] Retrieval is performed as soon as possible after death, and the acceptable interval from death to preservation may vary according to the circumstances of death and storage of the body.[7] One article suggests parameters of up to 12 hours after death, but retrieval preferably occurs within 6 to 8 hours.[10] Cornea recovery generally takes 45 minutes to an hour and cannot occur after embalming.[4] To remain viable, cor-

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Threat of Cornea Transplant Contamination (Continued)

neas are maintained at 2° to 8°C.[4,7,11] Other methods of preservation exist besides cold storage, such as storage in a nutrient medium, cryopreservation, and long-term incubation at 37°C.[3]

In France the annual demand for corneas exceeds the availability of donor corneas.[12] A recently published study of changes in retrieval and storage practices resulted in a reduction in the number of lost corneas due to contamination by 50%. The use of sterile physiological saline when closing the deceased eyelids in acute care settings was implemented along with changes to mortuary and eye bank practices.[12]

Managing Cornea Transplantation (Keratoplasty)

Penetrating keratoplasty is a surgical procedure in which diseased corneal tissue is removed and replaced with donor corneal material. This procedure can be done to improve visual clarity or to provide structural support.[3] Keratoplasty is "one of the most common transplantation procedures performed in the United States."[3]

When arrangements are made for keratoplasty, the surgery is scheduled, and either the ophthalmologist's staff or the staff from the facility where the procedure is performed orders the cornea. Usually, this occurs six weeks before surgery.[4] Upon the cornea's arrival, the facility verifies that the cornea is acceptable and appropriate for the recipient. Safe tissue storage and management are essential. Additionally, the facility provides the supportive laboratory services if culturing of donor eyes is to occur, either before or during surgery.

"All intraocular procedures have a risk of postoperative endophthalmitis, which is reported to be between 0.1% and 0.4% in the case of penetrating keratoplasty."[13] According to one published report, postkeratoplasty endophthalmitis did not occur in thirteen patients who received an implant from contaminated corneoscleral rims.[13] Based on that reported experience, one can expect that 95% of similar experiences should show that patients who receive contaminated corneas have an infection rate less than 25% (one in four).

Microbiological culturing of donor eyes may be performed by the eye bank; however, this is not standard practice because "bacteriologic contamination of donor eyes does not necessarily lead to infection and pre-surgical or surgical cultures may not correlate with postoperative infection if it should occur."[7]

Ultimately, the surgeon assumes responsibility for determining the suitability of the tissue for transplantation.[7]

To provide safe corneas, accredited eye banks must follow a structured process, which includes obtaining consent for retrieval, determining the cause of the donor's death, obtaining the donor's medical history, and performing various blood tests on specimens obtained from the donor. Facilities performing keratoplasty have, until recently, been left to map out their own policy or protocol in transplant tissue management.

Last summer, JCAHO issued new Provision of Care standards (effective as of July 1, 2005), with emphasis on acquiring, receiving, storing, and issuing tissue, as well as providing for the traceability of tissue and responding to related adverse events.[14] Additionally, JCAHO plans to offer an Organ Transplant Center Certification starting in 2006.[15] According to JCAHO, tissue specimens include "bone, cornea, skin, heart valves/conduits, tendons, fascia, dura, bone marrow, veins, arteries, cartilage, sperm, embryos, eggs, stem cells, cord blood, synthetic tissue (artificially prepared, human and non-human based), and other cellular- and tissue-based transplant or implant products."[16] The Provision of Care standards are summarized below.[16]

Standard PC.17.10 "The organization uses standardized procedures to acquire, receive, store, and issue tissues."[16] Elements of performance include:[16,17]

- Organizational coordination of tissue processing.
- Ensuring that suppliers are FDA registered or state licensed.
- Adhering to the instructions for tissue care and storage provided by the tissue or eye bank.
- Logging all incoming tissue.
- Ensuring that the temperature of all storage refrigerators and freezers is monitored and recorded daily. (Units must be alarmed and have an emergency backup.)
- Ensuring state and federal regulations are followed verifying package integrity and suitable transport temperature when accepting tissue.

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Threat of Cornea Transplant Contamination (Continued)

Standard PC.17.20 "The organization's record keeping permits the traceability of all tissues from the donor or source facility to all recipients or other final disposition."[16] Highlights of the elements of performance include:[16,17]

- Ensuring traceability of tissue from the donor to all recipients and final dispositions, including discarding of tissue.
- Tracking and identifying materials used to prepare or process tissues.
- Documenting which staff members were involved in preparing, issuing, and accepting tissue, as well as the date and time of receipt.
- Recording in the recipient's record the type and unique identifier of the tissue.
- Maintaining records, including temperature logs, procedures, manuals, tissue detail, and publications, for a minimum of 10 years or as required by federal or state laws.
- Returning tissue information cards to the source facility.

Standard PC.17.30 "The organization has a defined process to investigate adverse events to tissue or donor infections."[16] Elements of performance include:[16,17]

- Implementing procedures for investigating adverse events.
- Reporting all infections or adverse reactions to the source facility.
- Sequestering tissue that is reported as being potentially infectious.
- Notifying tissue recipients of possible infection.
- Ensuring that procedures have been followed when an adverse event has occurred or is suspected.

When determining whether a deceased individual is eligible for tissue donation, existing limitations include not only the cause of death, but also certain diseases or infections. FDA requires that potential donors be tested for HIV and hepatitis B and C. Hepatitis B transmission was reported in 1984 prior to the changes in the EBAA and FDA standards requiring donor testing. "Since 1986, when the EBAA initiated the requirement, there apparently have been no reports or publications documenting transmission of hepatitis B by way of corneal transplantation."[18]

The following are selected additional exclusion criteria for an allograft (living or nonliving) donor for human tissue:

- Having possible transmissible spongiform encephalopathy, such as Creutzfeldt-Jakob disease (CJD) (Exclusion also applies to individuals with a blood relative with noniatrogenic CJD, individuals with rapidly progressive dementia, recipients of human pituitary-derived hormones, and recipients of human dura mater grafts.)[5,8,16]
- Having autoimmune disease.[8]
- Having fever lasting at least seven consecutive days immediately before cardiac death.[8]
- Being ventilator dependent, immobile, or confined to bed for more than seven consecutive days immediately before cardiac death.[8]
- Having received a xenotransplant (a transplant from a nonhuman animal source) or being a xenotransplant recipient's close contact (because infectious agents from the donor animal may exist).[8]
- Demonstrating any of the high-risk criteria for HIV.[5,8]
- Specific to cornea tissue donors, having any intrinsic eye disease or prior intraocular or anterior segment surgery.[7]

When metabolic or bone disease, malignancy or malignant neoplasm, or disease of unknown etiology exists, AORN recommends that the medical director or medical committee review potential donors on a case-by-case basis.[8]

Reporting requirements for eye banks and surgical facilities are similar in that adverse events related to the transplant must be reported to EBAA. The EBAA medical standards require that any disease transmitted by and attributed to the transplant be

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Threat of Cornea Transplant Contamination (Continued)

reported. These recipient diseases include infections, biologic dysfunction, and even development of a systemic infectious disease such as HIV, hepatitis, syphilis, or CJD, regardless of whether the implanted tissue is the suspected cause.[7]

Cornea transplants provide the gift of sight, and essential in providing this opportunity is adherence to a regimen that is rigorous in providing oversight for each step in the procurement and transplantation process. Confidence in an eye bank's commitment to excellence stems from decades of successfully providing corneas for transplantation with minimal issues. Today, the expectations of facilities are heightened to include accountability for transplants, a structured process, documentation of tissue management, and archival of this documentation for at least a decade. Optimal transplants and process management are the ultimate goal in ensuring the safety of corneas for implantation.

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Patient Safety Authority Board of Directors

Governor Rendell has appointed Ana Pujols-McKee, MD, as a member and chair of the Patient Safety Authority Board of Directors.

Dr. McKee, who is chief medical officer and associate executive director of the Penn Presbyterian Medical Center in Philadelphia, was named to fill the seat designated for a physician. Dr. McKee received her medical degree from Hahnemann Medical College and is board certified in internal medicine.

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Demerol: Is It the Best Analgesic?

One of the most commonly used opioid analgesics on the market is meperidine (DEMEROL). Eisendrath, et al., claimed in 1987 that meperidine was the most widely used opioid analgesic in the US, prescribed by approximately 60% of physicians for acute pain and by 22% for chronic pain.[2] Of the top 10 drugs mentioned by general surgeons in 2004, based on projected data from a survey of general surgeons, Demerol injection was third on the list.[3]

Meperidine is considered to be an inappropriate medication for patients over the age of 65 based on the Beers criteria,[4] yet a 2006 study that examined the use of meperidine in patients over the age of 65 in two urban hospitals found that meperidine was administered to approximately one in eight older surgical patients at both institutions. In addition, surgical patients were more likely than medical patients to receive a dose of meperidine.[5]

> *"Demerol is an old, lumbering dinosaur which must be taken out of use in order that effective pain control can become a reality."*
>
> ***Dr. J. Davis Daniels***
> ***The Passing of Demerol*** [1]

Meperidine was initially produced in 1939 for its anticholinergic effects, but its analgesic properties were discovered soon thereafter. Morphine, at that time, was associated with many problems such as constipation, urinary retention, potential for dependency and respiratory depression while meperidine was thought to be an analgesic without these problems.[6] But initial studies demonstrating the analgesic efficacy of meperidine were mostly case reports and not double-blind, randomized, controlled trials in specific populations. Subsequent comparative studies failed to demonstrate any advantages of meperidine over comparable doses of other analgesics.[7] In fact, studies found that the analgesic effects of meperidine are not pronounced, and that meperidine has unique side effects including serotonergic crisis and toxicity by its metabolite, normeperidine.

Central Nervous System Effects

Meperidine is a phenylpiperadine opioid agonist analgesic with anticholinergic, serotonergic, and noradrenergic effects. Meperidine is metabolized in the body by two different pathways. The predominant pathway is hepatic carboxylesterase metabolism to meperidinic acid, an inactive metabolite.

Physicians can receive continuing medical education (CME) credits for completing the self-assessment questions related to this article. See page 27 for details.

However, the most clinically significant pathway is *N*-demethylation by the cytochrome P-450 system producing normeperidine, a nonopioid active metabolite.

Normeperidine has half the analgesic potency of meperidine but two to three times the potency as a central nervous system (CNS) excitatory agent. The accumulation of normeperidine has been shown to cause anxiety, hyperreflexia, myoclonus, mood changes, and seizures within 24 hours.[8] The bioavailability and half-life of orally administered meperidine are increased in patients with cirrhosis. For that reason, the use of meperidine in patients with cirrhosis is contraindicated due to increased risk of toxicity from accumulation of meperidine and normeperidine. Meperidine is also contraindicated in patients with renal impairment because normeperidine can accumulate in these patients.

The seizure activity produced by normeperidine makes meperidine stand out from other opioid analgesics. Seizures caused by normeperidine accumulation are a non-opioid effect; therefore, analgesic antagonists such as naloxone (NARCAN) will not stop this activity. Adverse drug reaction reports to PA-PSRS provide classic examples of this problem.

A patient received a 50 mg dose of Demerol for pain, which was not the first dose given to this patient. Shortly, the patient's roommate notified the nurse that the patient had fallen on the floor. The nurse found the patient on floor, face down and seizing. The patient was not responsive to verbal or physical stimuli, was turned over and placed in bed. Oxygen was applied and the patient slowly began responding after 3-5 minutes. Patient had a suspected history of seizures possibly associated with higher doses of Demerol.

A patient was ordered meperidine 100 mg I.M. every 3 hours as needed. Over a period of three days the patient received a total of 1900 mg of meperidine, which led to the patient developing seizures.

After receiving meperidine for a procedure, the parents of a pediatric patient reported to the recovery room nurse that the patient was twitching. They stated that the patient was

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Demerol: Is It the Best Analgesic? (Continued)

not doing this before. The nurse observed rapid eye movement and seizure-like head movements. The patient's arms were rigid and he was unable to extend his arm voluntarily, but was able to follow verbal commands. Approximately 30 minutes later no seizure like activity noted.

Clinically, the predominate side effect that differentiates meperidine from the other opioids is its neurotoxicity. Meperidine has been implicated in "Serotonin Syndrome."[9] Serotonin Syndrome (SS) is thought to be caused by high levels of serotonin (5-HT) in the CNS. Most cases of SS reported in the literature were associated with patients taking two or more medications that increase CNS serotonin levels by different mechanisms such as monoamine oxidase inhibitors (MAOI) used in conjunction with meperidine, tricyclic antidepressants, or Selective Serotonin Reuptake Inhibitor (SSRI) antidepressants.[10] Examples of commonly used SSRI antidepressants, also known as 5-HT-selective reuptake inhibitors, include fluoxetine (PROZAC), paroxitine (PAXIL), sertraline (ZOLOFT), and citalopram (CELEXA).

Common symptoms of SS that are similar with toxicity due to normeperidine evident in adverse drug reaction reports involving meperidine submitted to PA-PSRS include: altered mental status, agitation, shaking, tremors, dystonic cramping in legs, and restlessness. A more extensive list of common SS symptoms is presented in Table 1.

The Institute for Safe Medication Practices (ISMP) has reported on a case in which a 59-year-old woman experienced Seratonin Syndrome after meperidine PCA was discontinued due to hallucinations and agitation. When her symptoms worsened with IV lorazepam, a pharmacist investigated treatment options for what he thought was normeperidine metabolite accumulation, but he could find little information. He then called the Poison Control Center. After learning that the patient also was taking ZOLOFT (sertraline), Poison Control suggested that the patient might be suffering from Seratonin Syndrome. The nurse confirmed that the patient had several telltale symptoms (hyperreflexia, diaphoresis, diarrhea, disorientation, confusion, hallucinations). Cyproheptadine 4 to 8 mg orally every four hours was recommended, and the patient improved dramatically within the next several hours after receiving the drug.[12]

In a study to determine the cumulative doses of opioid agonists, Walker and Zacny called meperidine the most intoxicating of the narcotics tested. Meperidine had the largest mean peak ratings of "confused," "high," "drunk," "floating," "coasting," and "difficulty concentrating." They stated that meperidine had the most intense effects, but they were short lived, lasting approximately 5 minutes.[13]

Another problem with meperidine is the anticholinergic effect of meperidine owing to its blockade of muscarinic/acetylcholine receptors. Common side effects of anticholinergics include blurring of vision,

Table 1. Symptoms Associated with Serotonin Syndrome

Mental status changes	**Motor Abnormalities**
Confusion (51%)	Myoclonus (58%)
Agitation (34%)	Hyperreflexia (52%)
Hypomania (21%)	Muscle rigidity (51%)
Anxiety (15%)	Restlessness (48%)
Coma (29%)	Tremor (43%)
Cardiovascular	Ataxia/incoordination (40%)
Sinus tachycardia (36%)	Shivering (26%)
Hypertension (35%)	Nystagmus (15%)
Hypotension (15%)	Seizures (12%)
Gastrointestinal	**Other**
Nausea (23%)	Diaphoresis (45%)
Diarrhea (8%)	Unreactive pupils (20%)
Abdominal pain (4%)	Tachypnea (26%)
Salivation (2%)	Hyperpyrexia (45%)

Source: U.S. Pharmacist. Reprinted with permission.

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Demerol: Is It the Best Analgesic? (Continued)

constipation, agitation, confusion, delirium, and disorientation.

Analgesic Effects

Despite its popularity as an analgesic, numerous studies have shown the ineffectiveness of meperidine compared to other medications used for pain relief. Austin, et al., demonstrated the limitations of a scheduled dose of 75 mg of meperidine every 6 hours, with patients not achieving significant levels of pain relief for more than 24 hours after surgery.[14] During the initial post-dose 4-hour period, patients only received partial pain relief for 30 minutes.

In a comparison of three equipotent doses of meperidine with morphine delivered via PCA, Plummer, et al., found that the level of analgesia at rest following major abdominal surgery provided by both drugs was similar, but that on movement morphine provided better analgesia at the three doses that were compared in the study. [15]

In another PCA study, Bahar, et al., noted that overall pain relief was similar, but that pain on movement, after deep inspiration or coughing, and at rest was better with morphine than meperidine.[16] Vetter demonstrated in children using PCA devices that morphine produced significantly better pain scores than meperidine with no difference in the side-effect profiles. Further, the anxiolytic effect of morphine reduced the distress and suffering of the children when compared with meperidine.[17]

Jasani, et al., compared the therapeutic effects of 50 mg of meperidine to 1 mg of HYDROmorphone for the treatment of ureteral colic and demonstrated that with HYDROmorphone, patients needed fewer breakthrough medications (31% versus 68%), fewer intravenous pyelograms (28% versus 54%), and fewer hospital admissions (25% versus 49%). This study also reported improved analgesia with HYDROmorphone. Clinically, patient outcomes were significantly better with HYDROmorphone, and it provided more cost-effective treatment.[18]

In a study comparing the analgesic efficacy of IM doses of ketorolac, meperidine, and placebo after major orthopedic surgery, DeAndrade, et al., showed that ketorolac was significantly more effective than meperidine in duration of action and in the number of patients requiring additional medication 6 hours after the first dose. In addition, ketorolac was associated with significantly lower percentages of patients reporting adverse drug events.[19]

Not only has meperidine been shown to be an inferior analgesic compared to other opioids; it is also characterized by a limited duration of action. This effect may have some utility for short-duration procedures but is less than optimal for treating situations in which pain is of longer duration.[20]

Conclusion

Given the reports in the literature, its potential for seizures, its effects on the central nervous system, and its anticholinergic effect, meperidine may not be the optimal analgesic for the treatment of pain. The euphoric effects are reported to be more pronounced than with other analgesic agents, and it is the only agent associated with negative effects on mood. It has been shown to be a less effective analgesic than other agents with a capacity to cover mild to moderate pain.

The anticholinergic effect decreases the amount of secretions and thus enhances endoscopic procedures, and if used for moderate pain for less than 24 hours, practitioners can avoid the side-effect profile. The use of meperidine requires careful patient selection, since the Beers criteria classifies it as an inappropriate medication for individuals over 65 years of age. In addition, its use requires vigilant monitoring for neuron-excitatory effects and tracking of dosage to reduce the risk of neurotoxicity, as well as awareness of concomitant or recent use of serotonergic drugs to prevent potentially fatal drug interactions.

Since other opioid agonist analgesics have similar analgesic efficacy, lower risk of neurotoxicity at usual therapeutic doses, and lower risk for Serotonin Syndrome due to drug interactions, your facility may want to consider limiting the use of meperidine to those situations in which the benefits outweigh the risks.

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hydrOXYzine and hydrALAzine Mix-Ups

The December 2004 Advisory article "Medication Errors Linked to Drug Name Confusion" noted that mix-ups due to look-alike and sound-alike drug names had been reported in Pennsylvania facilities, and these types of errors continue to happen.

One look-alike and sound-alike pair that continues to be problematic is hydroxyzine and hydralazine (see Figures 1 and 2). Because the first four letters of their names are identical, they are frequently stored next to one another on pharmacy shelves and listed adjacently on computer screens. Their similar dosage strengths (10, 25, 50 and 100 mg) and tablet dosage forms also contribute to confusion.

If your institution stocks these drugs, relying on people to read labels does not prevent errors. People may believe that they have read the label, but other factors beyond their control may mislead them. Instead, change the appearance of look-alike product names on computer screens, pharmacy and nursing unit shelf labels and bins (including automated dispensing cabinets), pharmacy product labels, and medication administration records. You can differentiate these drug names by using boldface, color, and/or "tall man" letters, to help emphasize the parts of the names that are different (e.g., hydr**OXY**zine, hydr**ALA**zine). The accompanying pictures illustrate this technique.

Figure 1. Package Labels WITHOUT Tall Man Lettering. Image provided courtesy of ISMP.

Figure 2. Package Labels WITH Tall Man Lettering. Image provided courtesy of ISMP.

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Patient Safety in Mental Health: Reports from Behavioral Health Hospitals

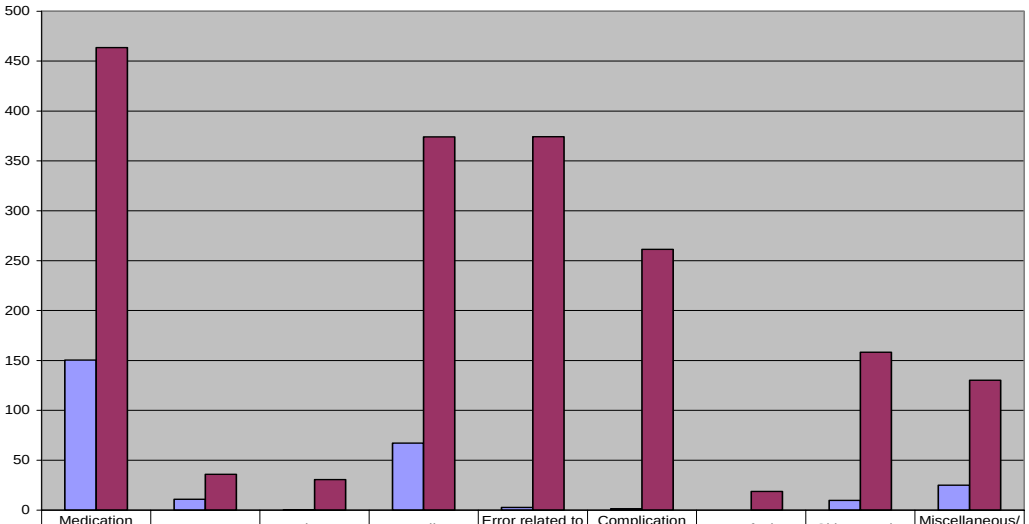
Through a Memorandum of Understanding with the Department of Health, behavioral health hospitals (BHHs) licensed by the Department of Public Welfare are required to submit reports to PA-PSRS under the Medical Care Availability and Reduction of Error Act of 2002 (Mcare or Act 13). Several patterns have been identified in over 1,200 BHH reports received during the 18-month period from July 2004 through December 2005. While some patterns reflect the uniqueness of BHHs, there are also similarities with other facility types. Information presented in this article may also be of interest to behavioral health units within other types of facilities.

PA-PSRS information is a foundation upon which facilities can identify opportunities for system improvements. While the following information may provide some insight into BHH report patterns, these patterns may not reflect actual patient safety problems at a specific facility. BHHs may wish to use this information as an impetus to delve more deeply into the causative factors associated with reports in their own facility.

Staff from some BHHs have expressed difficulty identifying reportable events due to the unique aspects of their clinical setting. This article may offer them some insight into the types of events reported by facilities like theirs.

Overall, BHHs submit far fewer reports to PA-PSRS than other hospitals. After adjusting for differences in volume, PA-PSRS receives about seven reports from non-BHH hospitals for every report submitted by a BHH, Even in light of a longer average length of stay, BHHs may have lower report submission rates because their patients tend to have fewer and less serious physical conditions than patients in general acute care hospitals. Further, they typically receive fewer and less risky interventions than patients in other types of hospitals.

As shown in Figure 1, BHHs submit proportionately fewer reports than non-BHHs in every category of event type. For example, Medication Error and ADR report submission rates were approximately one-third of the non-BHH rate. The rate of reports of Falls from BHHs was about one-fifth that from non-



	Medication Error	ADR	Equipment	Fall	Error related to PTT*	Complication related to PTT*	Transfusion	Skin Integrity	Miscellaneous/ Other
BHH RATE	150.3	10.8	0.2	67.3	2.6	1.5	0.0	9.9	25.0
Non-BHH RATE	463.6	35.8	30.6	374.1	374.4	261.4	18.8	158.1	130.3

Figure 1. Reports to PA-PSRS by Behavioral Health and Non-Behavioral Health Hospitals per 100,000 Patient Days (Jul 2004-Dec 2005) *PTT is an abbreviation for "Procedure, Treatment, or Test."

Reports per 100,000 patient days is a commonly used measure of healthcare utilization or volume. Because the average length of stay varies widely for BHHs (13.0 days) and non-BHHs (4.7 days), patient days is a better denominator than admissions for calculating comparative report submission rates. Reports per 100,000 admissions were calculated based on publicly available data from the website of the Pennsylvania Health Care Cost Containment Council (www.phc4.org). For each facility type, the number of reports from hospitals occurring from July 2004 through December 2005 was divided by the number of patient days reported during the third and fourth quarters of 2004, the first and second quarters of 2005, and forecast patient days for the third and fourth quarters of 2005. Because only partial data were available for 2005 at the time this article was written, we forecast patient days for the last two quarters using seasonal decomposition.

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Patient Safety in Mental Health: Reports from Behavioral Health Hospitals (Continued)

BHHs. While this highlights the differences in patient populations and interventions between these types of facilities, it is also worth noting that Medication Errors and Falls are significant patient safety concerns in all of these healthcare settings.

Examining the distribution of reports by Event Type from BHH and non-BHH facilities (see Figure 2) finds some similarities and some differences between these care settings. BHHs have submitted reports for all major Event Type categories except Transfusion. As in non-BHH facilities, Medication Errors and Patient Falls are the most prevalent types of reports.

In contrast, BHHs reported proportionately fewer Errors and Complications Related to Procedure/ Treatment/Test; and issues related to Skin Integrity and Equipment. There are a number of reasons for these differences. Patients in BHHs undergo considerably fewer procedures, treatments, and tests compared to patients in non-BHHs. BHH patients are generally more mobile and are therefore at lower risk for skin integrity problems.

While BHHs have reported fewer Medication Errors and Adverse Drug Reactions per patient day than non-BHHs, these types of events constitute a greater proportion of reports from BHHs. In part, this is likely because of BHH patients experiencing fewer opportunities for Errors or Complications Related to Procedures, Treatments, or Tests, but it may also reflect the quantities and/or types of medications administered in these facilities. In addition to maintenance medications for chronic conditions, such as asthma or diabetes, psychotropic medications are associated with extrapyramidal symptoms.

Medication Errors

Fifty-five percent (55%) of reports from BHHs were medication errors, compared to 25% from non-BHH facilities. Among both types of facilities' medication error reports, dose omissions predominated in both. However, BHHs reported a greater proportion of extra dose, wrong drug, and wrong patient errors.

Dose Omissions

Transcription errors contributed to about two-thirds of reports of dose omissions. These involved mainly failure to transcribe, kardex recopying problems, and incorrect/inaccurate transcription. Reported missed doses were often overlooked at bedtime or when the patient was off the unit or out on a pass.

The medication process also broke down at points where orders needed to be clarified or when follow-up was indicated and did not occur. Some of these points include: when an ordered medication was not on formulary/not available; when parental consent was required; or when orders were unclear about the dose/dosing schedule, type/form of medication, timing, or when an automatic stop order was instituted for a necessary medication.

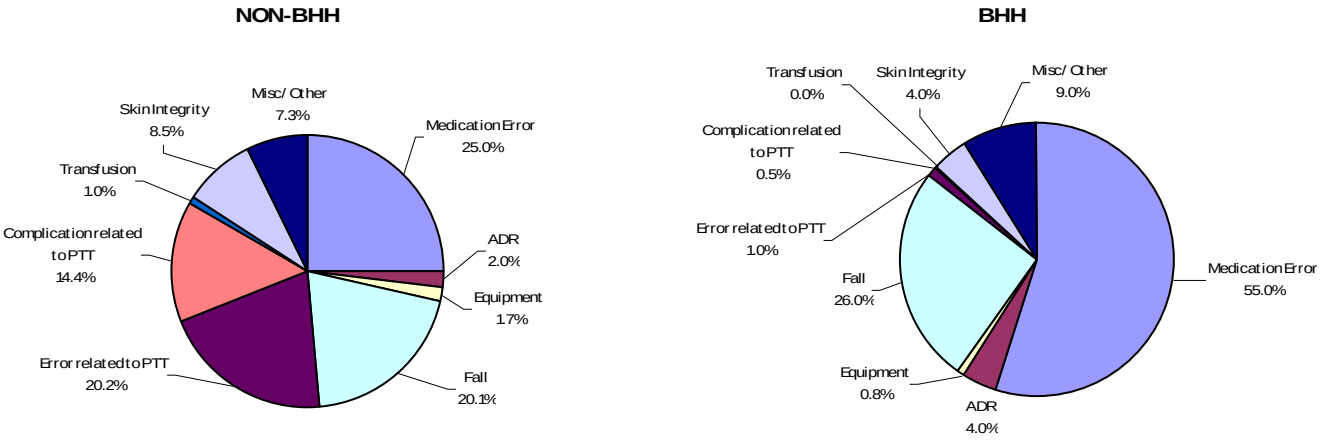

Figure 2. Distribution of Reports to PA-PSRS by Event Type, Behavioral Health and Non-Behavioral Health Hospitals (Jul 2004-Dec 2005)

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Patient Safety in Mental Health: Reports from Behavioral Health Hospitals (Continued)

Other instances of reported dose omissions include:

- Nurses unaware that the medication was in the medication drawer, because the brand name was dispensed instead of the generic name (or vice versa).
- Parenteral medications not given as ordered when a patient refused oral medications.
- Computer system problems contributing to omissions.

Extra Doses

Transcribing the wrong medication frequency also caused the majority of extra dose errors. About one-fourth of these reports involved failure to discontinue a medication. Recopying medication kardexes also resulted in such errors. In some cases, medications were administered after the physician discontinued the order. In others, patients received a medication while out on a pass and received an extra dose upon returning to the unit.

Wrong Drug

Wrong drug errors involved several look-alike/sound-alike drugs. For example, the most frequently mentioned wrong drug pair was Klonopin and Ativan. While not mentioned in the reports, these medications have look-alike/sound-alike generic names (Clonazepam, Lorazepam).

Another frequently reported pattern involves confusion between extended release and regular drug versions:

- Adderall XR versus Adderall (predominant wrong drug error).
- Lithium Carbonate versus Lithium ER, Lithium SR.
- Depakote ER versus Depakote.

Patients often received incorrect sound-alike insulin formulations: Humalog versus Humulin, Humulin70/30 and Humalog 75/25. Also, while both are dextroamphetamines, several reports indicated that Adderall was given instead of Dexedrine (and vice versa).

Several wrong drug errors involved other drugs used in behavioral health with similar letter strings. Examples are shown in Table 1.

Table 1. Similar Letter Strings in Behavioral Health Medications Can Promote Confusion

Many drugs prescribed for behavioral health patients have similar letter strings in their names. Those specified below have been implicated in wrong drug error reports submitted to PA-PSRS by behavioral health facilities. Using tall man letters for look-alike/sound-alike drugs may reduce wrong drug errors.

Lorazepam Clonazepam Alpraxolam	Cymbalta Cylert
Clonidine Klonapin	Topamax Toprol XL
Hydroxyzine Hydralazine Hydrochlorothiazide	Lovastatin Prevastatin
Suboxone Subutrex	Fiorcet Percocet
Sinequan Seroquel	Oxycontin Oxycodone
Citalopram Escitalopram	Humulin Humulin 70/30 Humalog 75-25

Beware of the X in the middle

Several BHH wrong drug reports involved:
CeleXa
EffeXor
LeXapro
NeXium
ZypreXa

Almost half of the wrong drug reports indicated the following contributing factors: pharmacy dispensing errors, transcription errors, and misidentification (e.g., wrong patient; wrong kardex referred to; many patients requesting medications at the same time; nurse who administered medications was not the same nurse who poured the medications).

Wrong Patient

In reports involving administration of a drug to the wrong patient, the predominant contributing factors include:

- Not using two identifiers.
- Medication was transcribed onto another patient's medication administration record.

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- Patients with similar names.

In a few instances, instead of asking, "What is your name?" the healthcare worker asked if the patient was a specific name, and the wrong patient said "yes." In other instances, the wrong patient presented him/herself for the medication when a name was called out, and the healthcare worker assumed that it was the correct patient.

The following systems solutions may help to reduce the incidence of medication errors:

- Reducing the need for recopying medication administration records.
- Developing consistent mechanisms to ensure administration of medications at bedtime and when patients return from passes/other departments.
- Having Pharmacy label dispensed medications with both generic and brand names.
- Posting a list of brand and generic names of drugs commonly used in behavioral health.
- Consistently applying a protocol to ensure that ordered parenteral medications are given when patients refuse oral medications.
- Implementing a system to flag/remind healthcare workers to follow up when medications require clarification.
- Concerning look-alike, sound-alike and regular vs. extended release medications:
  - Using tall-man lettering system or unique labels to differentiate medications.
  - Separating such medications to avoid confusion.
  - Posting a list of commonly confused medications.
- Using at least two patient identifiers to ensure that the right drug is given to the right patient.
- Requiring the person who pours a medication to be the one to give the medication.
- Pouring and administering one patient's medications at a time.
- Moving to Pharmacy-dispensed unit dosing that is administered individually to one patient at a time, rather than prepouring medications for several patients at once.
- Asking patients to state their names, rather than asking "Are you X?"
- Regularly sharing medication dispensing error information with the Pharmacy to encourage investigation and process improvement.

Adverse Drug Reactions

Among adverse drug reactions (ADRs) reported to PA-PSRS from BHH, almost two-thirds involved one of the following six medications: Risperdal, Haldol, Seroquel, Lithium, Lamictal, or Trazadone. Three-fourths of the ADRs were: extrapyramidal symptoms and/or rashes.

There were a couple of very serious ADRs. One report revealed that psychotropic medication resulted in neuromalignant syndrome. However, serious reactions were not associated only with psychotropic drugs. In another case, an antibiotic was associated with toxic epidermal necrolysis. Both of these life-threatening conditions required patient transfer for intensive medical intervention.

Methods for preventing ADRs include:

- Heightening staff awareness of the medications most frequently associated with ADRs, taking into account those used commonly in your facility.
- Making staff aware of symptoms and interventions, not only of common psychotropic ADRs, but also rare ADRs such as neuromalignant syndrome.
- Behavioral health clients may also experience ADRs from non-psychotropics, such as antibiotics. Assessment for and intervention in such ADRs may reduce risk in life-threatening circumstances.

Patient Falls

Compared to non-BHHs, a greater proportion of BHHs' reports of patient falls involved falls while ambulating, in hallways, and on the grounds of the facility. BHH patients are likely to be in better physical condition and are capable of ambulating greater distances than are acute hospital patients. Yet,

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other factors involved in many BHH falls may be similar to those in acute hospital patients.

The reports indicated several contributing factors that place BHH patients at risk, including: physical symptoms (dizziness, lightheadedness, loss of balance, syncope, seizures); and wet floors. Two-thirds of the falls occurred from 7pm to 7am. Many patients who fell while lying in bed were either asleep or were reaching for something. One-fourth of falls from a seated position involved wheelchairs or benches/chairs tipping.

One-half of the fall reports did not indicate completion of a fall risk assessment or implementation of fall precautions. Yet, two-thirds of these reports specified medications given prior to the fall that may produce symptoms that increase fall risk, such as benzodiazepines, anti-seizure medications, and/or antipsychotics. Of the fall reports specifying medications, 40% indicated that patients received multiple drugs prior to the fall. Polypharmacy also increases fall risk.

Methods to help reduce falls, or to reduce harm from falls, include:

- Evaluating the circumstances surrounding falls associated with elimination/use of bathrooms.
- Adjusting medications to reduce dizziness, lightheadedness, loss of balance.
- Evaluating activities and correcting patient safety hazards in recreational areas, smoking areas, courtyards, sidewalks/walkways, to reduce injuries.
- Controlling seizures with medication.
- Securing furniture and equipping ambulatory aids with anti-tip devices, when available.
- Using partial siderails when patient is asleep and at night.
- Keeping patient items within reach.
- Because of medications (particularly benzodiazepines and anti-seizure), assessing all behavioral health patients for fall risk.
- Implementing fall precautions consistent to level of risk assessed, particularly with patients taking multiple medications, benzodiazepines, and anticonvulsants.

Other Reports

Certain types of reports are more likely to come from BHHs than non-BHH facilities because of the unique clinical setting and patient mix. For example, injuries during recreational activities are frequently reported, as are instances of aggressive behavior in behavioral health patients either towards one's self or other patients, and possession of contraband. Some reports also indicate cases in which a change in physical condition requires transfer to acute care.

Conclusion

PA-PSRS provides a wealth of information for behavioral health hospitals. PA-PSRS is a springboard from which these facilities can monitor their own data to identify unique patterns and contributing factors. From this information, they can then develop corrective actions, measure outcomes, and ultimately improve patient safety.

Act 13 Amended to Include Abortion Facilities

Act 30 of 2006, which was signed into law on May 1, 2006, adds certain abortion facilities to the list of healthcare facilities subject to Act 13 reporting requirements. Under the law, facilities that perform 100 or more abortions during a calendar year will be required to comply with statewide mandatory reporting at the start of the next calendar year. That means that eligible abortion facilities will begin submitting reports of Serious Events and Incidents on January 1, 2007.

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Self-Assessment Questions

Patient Safety Officers told us in a recent PA-PSRS user survey that it would be helpful to have sample questions about selected *Advisory* articles that they could use for internal education and assessment. You may want to use the following examples or come up with your own.

Through a partnership between the Patient Safety Authority and the Pennsylvania Medical Society, physicians may obtain AMA PRA Category 1 Credit™ for completing a similar assessment. Visit the Medical Society website at www.pamedsoc.org/cme for more details.

Improving the Safety of Telephone or Verbal Orders

1. JCAHO's National Patient Safety Goal on verbal orders states that the receiver of the verbal or telephone order should **write** down the complete order to enter it into a computer, then **read** it back, and receive **confirmation** from the individual who gave the order or test result.
   A. True
   B. False

2. When communicating medication orders verbally, practitioners can do which of the following to prevent errors?
   A. Provide the purpose of the prescribed medication.
   B. Limit verbal orders to formulary drugs.
   C. Limit verbal or telephone orders to urgent situations.
   D. All of the above

3. Studies have demonstrated that the use of a read-back mechanism with verbal orders prevent medication errors.
   A. True
   B. False

4. Examples of contributing factors that led to medication errors when communicating orders verbally include:
   A. Sound-alike drug name pairs that have been misheard
   B. Numbers associated with drug strengths or number of doses that sound-alike
   C. Multiple medications are communicated verbally
   D. Patient's lab values were verbally communicated, but misinterpreted by the receiver
   E. All of the above

Demerol: Is It the Best Analgesic?

1. Which metabolite of meperidine is associated with seizure-producing neurotoxic side effects?
   A. Meperidinic acid
   B. Normeperidine
   C. Hydroxynormeperidine
   D. None of the above

2. What side effects are associated with the accumulation of normeperidine?

   A. Myoclonus
   B. Anxiety
   C. Hyperreflexia
   D. Seizures
   E. All of the above

3. All of the following have been demonstrated in studies involving meperidine except?
   A. Morphine produced better pain scores than meperidine
   B. Ketorolac was more effective than meperidine in duration of action
   C. Meperidine produced significantly better pain scores than morphine with children using PCA devices
   D. Hydromorphone demonstrated fewer breakthrough medications were needed and improved analgesia than meperidine

4. What symptoms are associated with Serotonin Syndrome?
   A. Agitation
   B. Confusion
   C. Myoclonus
   D. Tremor
   E. All of the above

5. Meperidine is an appropriate medication to be prescribed to any patient over 65 years of age.
   A. True
   B. False

Hydrofluoric Acid Exposure—A Double Whammy That's Not Just Skin Deep

1. Hydrofluoric (HF) acid produces tissue damage by:
   A. Fluoride ions penetrating the tissue, combining with calcium and magnesium, and causing chemical burns
   B. Free hydrogen ions causing corrosive burns
   C. Fluoride ions combining with other cations to make soluble salts that quickly dissociate, freeing fluoride ions to cause further damage
   D. All of the above

2. Dilute HF acid exposure should be suspected if pain is out of proportion to the injury observed upon initial examination.
   A. True
   B. False

3. Life-threatening electrolyte imbalances may occur when as little as what amount of body surface area is exposed to concentrated HF acid:
   A. 1%
   B. 5%
   C. 10%
   D. 15%

4. Obtaining an adequate history of HF acid exposure includes:
   A. Name of product, ingredients, chemical concentrations
   B. Protective measures used
   C. First aid provided
   D. Medications/antidotes given
   E. Duration of exposure
   F. All of the above

5. It is appropriate to treat all types of HF acid exposures with 10% calcium gluconate.
   A. True
   B. False

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PATIENT SAFETY AUTHORITY

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, as contractor for the PA-PSRS program, is issuing this newsletter 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 website at www.psa.state.pa.us.

ECRI A NONPROFIT AGENCY

ECRI is an independent, nonprofit health services research agency dedicated to improving the safety, efficacy and cost-effectiveness of healthcare. ECRI's focus is healthcare technology, healthcare risk and quality management and healthcare environmental management. ECRI provides information services and technical assistance to more than 5,000 hospitals, healthcare organizations, ministries of health, government and planning agencies, and other organizations worldwide.

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.

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