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University of Michigan Bio

The University of Michigan Health System includes the U-M Medical School and its Faculty Group Practice, three U-M hospitals, approximately 30 health centers and 120 outpatient clinics, M-CARE, and the Michigan Health Corp. The complex is licensed for 865 inpatient beds with admissions (excluding newborns) of over 43,000 patients yearly.

University Hospital is the Health System's hospital for adult patients. The 11-story, 550-bed hospital first opened its doors in 1986. Today, 70 percent of University Hospital's patients are admitted from communities or regional hospitals outside the Ann Arbor area. In its 1,796,262 square feet, the hospital houses diagnostic equipment, clinical laboratories, operating rooms and inpatient and intensive care units.

C.S. Mott Children's Hospital is known worldwide for its excellent clinical, educational and research programs. Experienced and innovative colleagues with diverse expertise collaborate to provide the highest-quality family-centered care for pregnant women, newborns, children and adolescents. A new children's hospital is currently planned and is expected to be operational by 2011.

Women's Hospital opened in 1950 as a center dedicated to the care of pregnant women in a family atmosphere. Women's Hospital is Southeast Michigan's regional perinatal center for high-risk pregnancies. A variety of specialized outpatient gynecological services are provided in such areas as gynecology/oncology, endocrinology, infertility and psychosexual counseling.

This Clinical Perspective has been underwritten by Hospira. Dr. Mitchell's article reflects his experience at the University of Michigan Health System. The information contained herein may not be typical of all institutions.

Development of the LifeCare PCA® Infusion System Drug Libraries—University of Michigan Health System

The drug libraries created for use with Hospira's LifeCare PCA (Patient-Controlled Analgesia) infusion system with Hospira MedNet® software can be developed to provide a flexible and high level of customization. At the University of Michigan Health System, one of the goals of the committee responsible for the pump's drug library development was to create a system with very specific parameters for infusion, which is particularly important for the pediatric population. An important objective for the committee was to allow nurses to select the appropriate clinical care area (CCA) without requiring physician input for the library selection itself. Finally, the committee wanted the flexibility to vary the programmed medication dose based on the degree of opioid tolerance of an individual adult patient.

A subcommittee of the Health System's Medication Safety Committee analyzed their particular needs and developed the drug libraries over a period of seven months. This pharmacy-led collaborative effort included nursing experts from the pediatric and adult acute pain service. For each medication chosen for inclusion, a template was developed to define lower limits, soft and hard upper limits and total dose per lockout period. The data, in turn, dictated the allowable drug concentrations.

After several months refining the information, key individuals and committees were chosen to validate the drug libraries. For example, the pediatric components of the libraries were reviewed by select pediatric anesthesiologists. As the subcommittee considered that the end-of-life patient population would constitute a small yet important portion of patients requiring higher opioid doses, a key physician involved in end-of-life care reviewed the adult maximum drug concentrations. The tentative final versions of the libraries were reviewed, in turn, by

the Medication Safety Committee; the pain subcommittee of the Pain, Sedation and Analgesia Committee; and the Pharmacy and Therapeutics Committee.

DRUG LIBRARY DEVELOPMENT

The drug library created for morphine, a commonly dosed drug, provides an excellent example of how a library can be customized for a complex patient environment characteristic of tertiary care centers like the University of Michigan Health System. It also provides an example of the flexible programming available with the LifeCare PCA infusion system when creating and defining a CCA.

Library CCA names are typically created based on specific patient care areas or units, such as ICU, PACU, Pediatrics, etc. At the University of Michigan, however, the CCA names were chosen to distinguish different adult and pediatric *patient populations* across the institution ... a creative solution designed by the subcommittee and facilitated by the Hospira MedNet software.

The CCA names developed for adult patients were divided into three different populations:

1. Opioid-naïve—the usual patient population undergoing PCA, "normal dose adult patients"
2. Opioid-tolerant—patients receiving chronic, frequently high-dose therapy, such as patients with cancer, "high dose adult patients"
3. High doses of opioids—such as patients at end-of-life, "maximum dose adult patients"

The term "opioid-naïve" refers to patients who have not received chronic opioid therapy prior to commencing PCA, while "opioid-tolerant" refers to those who have done so.

The CCAs created for the pediatric patient populations were based on patient weight, with initial weight ranges narrow for the youngest patients and then widening as the age advanced:

- | | |
|---------------|----------------|
| 1. 1-2.4 kg | 7. 20-24.9 kg |
| 2. 2.5-4.9 kg | 8. 25-29.9 kg |
| 3. 5-7.4 kg | 9. 30-39.9 kg |
| 4. 7.5-9.9 kg | 10. 40-49.9 kg |
| 5. 10-14.9 kg | 11. > 50 kg |
| 6. 15-19.9 kg | |

The subcommittee members determined that differentiating pediatric dosing by weight categories, in contrast to the three-tiered adult classification, would eliminate the need for physicians to select additional pediatric dosing criteria ("normal dose," "high dose" or "maximum dose").

Throughout the institution, morphine was available in four concentrations: 100 mcg/mL, 1 mg/mL, 5 mg/mL and 10 mg/mL. For the drug library, however, each patient population was restricted to the use of a concentration specifically appropriate for that population. In the clinical setting, for example, if a nurse attempted to use a drug concentration other than the concentration programmed for that particular population, the pump would not infuse. The nurse would then see a message on the screen stating that the medication was not allowed in the selected CCA.

In addition, when solutions were admixed by pharmacy, a label identifying the patient population was affixed to the bag as a reminder to the clinician programming the pump to select that specific CCA name. In pediatric patients, therapy was always initiated with the lower drug concentration, depending upon the patient's weight. With delivery of morphine in patients weighing 10 to 19.9 kg, a change to the higher drug concentration was made only if more than four syringes were being used in a 24-hour period. Approval to make this change was provided by the pain service staff who routinely reviewed such patients.

Table 1 illustrates the morphine solutions allowed for use by each patient population (each CCA name):

THE DRUG LIBRARY IN ACTION

Prior to implementation of the LifeCare PCA infusion system, the Health System evaluated 24 consecutive PCA-related incidents occurring over a six-month period. This evaluation revealed that one-third of those incidents could be traced to the erroneous programming of either fentanyl or hydromorphone concentrations. After implementation of the device on May 25, 2006, through the writing of this paper in November 2006, no entry errors were reported for fentanyl or hydromorphone out of 1,830 PCA infusions. The improvement observed with entry errors was felt to be directly related to the use of pharmacy-generated bar coding, which could be scanned by the LifeCare PCA infusion system.

Changes to the drug library itself are infrequent; only one change has been made since program initiation. This change was temporary, patient-specific, and was reversed when that patient was discharged from the hospital. The Health System staff who are empowered to make library changes include two members from pharmacy in addition to the subcommittee lead and Medication Safety Coordinator, John F. Mitchell, Pharm.D., FASHP, who can also perform this function off-site.

The University of Michigan Health System utilized the Hospira MedNet® software to conform to their criteria for flexibility and customization. Their development of the drug library reflects a creative approach to providing safe, individualized patient care with PCA.

Table 1

Patient Population	Morphine Sulfate Concentrations			
	100 mcg/mL	1 mg/mL	5 mg/mL	10 mg/mL
Normal dose adult		<input checked="" type="checkbox"/>		
High dose adult			<input checked="" type="checkbox"/>	
Maximum dose adult				<input checked="" type="checkbox"/>
Ped. 1-2.4 kg	<input checked="" type="checkbox"/>			
Ped. 2.5-4.9 kg	<input checked="" type="checkbox"/>			
Ped. 5-7.4 kg	<input checked="" type="checkbox"/>			
Ped. 7.5-9.9 kg	<input checked="" type="checkbox"/>			
Ped. 10-14.9 kg	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
Ped. 15-19.9 kg	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
Ped. 20-24.9 kg		<input checked="" type="checkbox"/>		
Ped. 25-29.9 kg		<input checked="" type="checkbox"/>		
Ped. 30-39.9 kg		<input checked="" type="checkbox"/>		
Ped. 40-49.9 kg		<input checked="" type="checkbox"/>		
Ped. > 50 kg		<input checked="" type="checkbox"/>		

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