Minimizing Prescription Writing Errors: Computerized Prescription Order Entry

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I. Background

Iatrogenic errors producing serious and often preventable injury occur frequently in hospitalized patients.[1] The landmark 1999 report by the Institute of Medicine "To Err is Human", estimated that iatrogenic injury results in 44,000 to 98,000 preventable deaths in the United States each year.[2] Medication errors are the most common type of iatrogenic errors.[3] Children have a three-fold greater risk of experiencing a medication error than adults and are more likely to be harmed.[4] Compared to the inpatient setting, there is much less information known regarding the epidemiology of medication errors and adverse drug events (ADEs) in the ambulatory setting. In one study, 31.5% of patients recently discharged from the hospital reported an ADE, and another study found that 5% of patients per year report an ADE.[5, 6]

Few data are available regarding the frequency of medication errors or ADEs in the pediatric ambulatory setting, and it is likely that outpatient drug errors are a major problem that has not been fully investigated. In a recent study of potential medication dosing errors in outpatient pediatrics, investigators reported that approximately 15 % of children were dispensed a medication with a potential dosing error, and analgesics were the most likely to be potentially overdosed. [7] In children, drug doses are usually calculated individually based on age, weight, and clinical condition and the difference between therapeutic and toxic drug levels is smaller than for adults. Additionally, all children, and newborns in particular, have less reserves than adults to buffer errors and young children have less developed communication skills with which to recognize or communicate potential mistakes or to describe signs of adverse effects. [4, 8, 9]

While medication errors can occur during drug ordering, transcribing, dispensing, administering, and monitoring, most adverse drug events (ADEs) occur at the stage of prescription writing or drug ordering (68-75%).[10, 11] These mistakes involve incorrect dosing or dosing calculation, incorrect medication, failure to use "best prescription writing practice" (e.g., decimal points, units, and abbreviations), handwriting legibility, and dosage forms.[11, 12] Errors involving opioid analgesics are among the most pernicious. However, little is known about the epidemiology of analgesic medication errors in patients being discharged from the hospital.

II. Prescribing Error Study at Johns Hopkins Hospital

We performed a prospective observational study of the analgesic prescriptions and discharge forms of pediatric patients discharged from our Children's Center. We found that discharge prescription errors for children requiring potent, opioid analgesic

drugs in the management of pain were very common; 81% of the prescriptions examined contained one or more errors. The most common errors were missing or wrong patient weight and incomplete dispensing information. Of most concern, we discovered a small number of prescriptions (2.9%) with the potential to cause significant injury. All of the prescriptions analyzed in this study were written by residents and fellows in training and likely lacked an independent review by an attending physician or pharmacist who may have intercepted the error. Prescriptions written by house staff have a high incidence of error and prescription writing skills are often overlooked in resident education.[7, 13-15]

Mistakes in pediatric prescriptions are predictable given the current method of prescribing and these errors are particularly common for analgesics. Accurate prescribing requires an accurate weight, proper conversion of pounds to kilograms, and the choice of an appropriate medication preparation and concentration. Drug dosing in pediatrics is calculated individually based on age, weight, and clinical condition. Their small size makes children more vulnerable to dosing errors because of a misplaced decimal point or trailing zero, and, when errors occur, young children have less developed communication skills with which to recognize or communicate potential mistakes or to describe signs of adverse effects. Dosing errors for opioid analgesics is of particular concern because these drugs have very narrow therapeutic indexes and increasingly patients are discharged home even when they are still experiencing moderate to severe pain. Indeed, overdosage can have serious and even fatal consequences. Young children and medically compromised children are at greatest risk. Underdosage is also of concern. The failure to provide adequate analgesia can have serious consequences and result in unnecessary suffering.

III. Strategies to Decrease Error Rates

Single errors in prescription writing are rarely catastrophic. However, multiple, smaller failures can often lead up to the actual hazard. Indeed, the high rate of medication errors highlights the importance of developing, testing and implementing effective error-prevention strategies. Several strategies have been effective in reducing medication errors. In adult in-patient studies, the review of medication orders by clinical pharmacists has been shown to substantially reduce medication error.[16] Clinical decision support systems (CDSS) have shown trends toward a decrease in drug toxicity.[17] The Institute of Medicine has identified computerization of medication prescribing as an important patient safety strategy.[2] Implementation of computerized provider order entry (CPOE) with decision support has been shown to reduce medication errors in hospitalized children by 40% to 97%. [18, 19]Many of the commercially available computerized provider order entry (CPOE) programs do not currently provide weight and age based dosage decision support and do not contain mechanisms to alert physicians to potential over- and under-dosing. Even if they do, the impact of CPOE on medication errors is uncertain. Nevertheless, principles from safety sciences should guide the development of safety systems. These include standardizing the prescription process, creating independent checks for key steps in the process, and learning from mistakes when they occur.

IV. Development of the Controlled Substances Prescription Writer

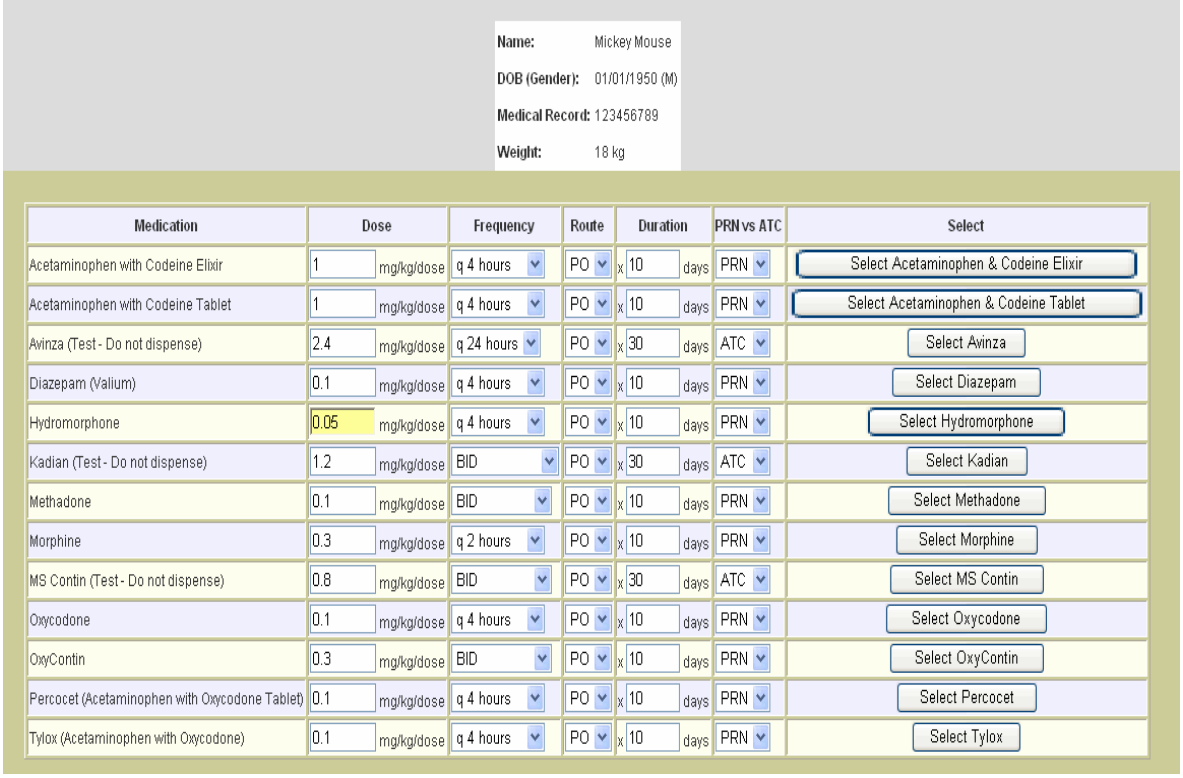
Based on our experience with error reduction through CPOE in total parenteral nutrition, chemotherapy, and continuous medication infusions we developed a computer-based controlled substances prescription writing program that is linked to the hospital's patient demographic database and contains weight-based dosing and decision management to reduce the potential for errors.[20-22] This web-based program was deployed in September 2005. The program initially gives the user a screen that identifies patient demographic information and provides common doses of medications (Figure 1). There are two types of alerts that are generated by the program: 'soft' alerts which identify doses that are outside of the designated usual range of dosing that the provider can override and 'hard' alerts which do not allow provider override (Figure 2). The dose ranges for decision support were based on expert consensus by members of the Pediatric Pain Service. Once the provider chooses a dose that is within the allowable parameters, dosing frequency and dispensing information is chosen and a legible, complete prescription is generated and given to the patient's family (Figure 3). We have studied the initial six months of deployment of the system and analyzed the utility of the program. Issues of legibility and inappropriate/ambiguous nomenclature were corrected immediately using the program. The program provided real-time feedback to providers that their selected dosing was outside the range of usual analgesic doses. Prescriptions with alerts were often abandoned likely reflecting the successful prevention of dosing errors. In a survey of users, adoption of the technology was generally well accepted. An additional benefit of this system was to enhance a systems-based review of prescription-based safety initiatives. Tracking the source of errors after a sentinel event was previously a labor-intensive process often requiring chart review and consultation with dispensing pharmacies. When a child presented to the ED with oxycodone overdose, we were able to identify that the pharmacy had dispensed a 20 mg/ml concentration while the computer-based prescription indicated a 1 mg/ml concentration. While the program did not prevent this error, it assisted in the rapid investigation of the cause of the patient's symptoms.

V. Conclusions

Adverse drug events (ADEs) are a significant public health problem and are estimated to injure or kill more that 770,000 hospitalized patients annually. [23] In a study of outpatient prescribing errors in adult primary care practices, Gandhi et al reported that prescribing errors occurred in 7.6% of outpatient prescriptions. They found 3% of prescriptions had the potential for patient injury. The prevalence of potential ADEs that occur in an ambulatory setting is estimated as 8 per 1000 prescriptions in adults, extrapolating to potentially 24 million serious potential events in the USA.[24] Prescribing errors are the most frequent source of ADEs, and CPOE systems are widely viewed as a potential solution by reducing prescribing errors resulting in decreased injury and potential health care cost savings. Published studies report that the use of CPOE systems reduces medication errors up to 81%.[25-27] However, some investigators have cautioned that the use of these systems may actually facilitate some medication error risks.[28, 29] The use of CPOE without clinical decision support systems is unlikely to impact on medication errors.[25, 30] The use of computerized order systems has not been widely

adapted in the USA but is likely to become more commonplace. Until computerized prescription writing CPOE with CDSS to reduce errors is widely available, health care providers and parents need to be vigilant about medications prescribed, particularly in the youngest and smallest patients.

Figure 1: Web-based Controlled Substances Script Writer



Name: Mickey Mouse
DOB (Gender): 01/01/1950 (M)
Medical Record: 123456789
Weight: 18 kg

Medication	Dose	Frequency	Route	Duration	PRN vs ATC	Select
Acetaminophen with Codeine Elixir	1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Acetaminophen & Codeine Elixir
Acetaminophen with Codeine Tablet	1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Acetaminophen & Codeine Tablet
Avinza (Test - Do not dispense)	2.4 mg/kg/dose	q 24 hours	PO	x 30 days	ATC	Select Avinza
Diazepam (Valium)	0.1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Diazepam
Hydromorphone	0.05 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Hydromorphone
Kadian (Test - Do not dispense)	1.2 mg/kg/dose	BID	PO	x 30 days	ATC	Select Kadian
Methadone	0.1 mg/kg/dose	BID	PO	x 10 days	PRN	Select Methadone
Morphine	0.3 mg/kg/dose	q 2 hours	PO	x 10 days	PRN	Select Morphine
MS Contin (Test - Do not dispense)	0.8 mg/kg/dose	BID	PO	x 30 days	ATC	Select MS Contin
Oxycodone	0.1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Oxycodone
OxyContin	0.3 mg/kg/dose	BID	PO	x 10 days	PRN	Select OxyContin
Percocet (Acetaminophen with Oxycodone Tablet)	0.1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Percocet
Tylox (Acetaminophen with Oxycodone)	0.1 mg/kg/dose	q 4 hours	PO	x 10 days	PRN	Select Tylox

Figure 2: Example of 'Hard' Alert Generated During Prescription Writing Process

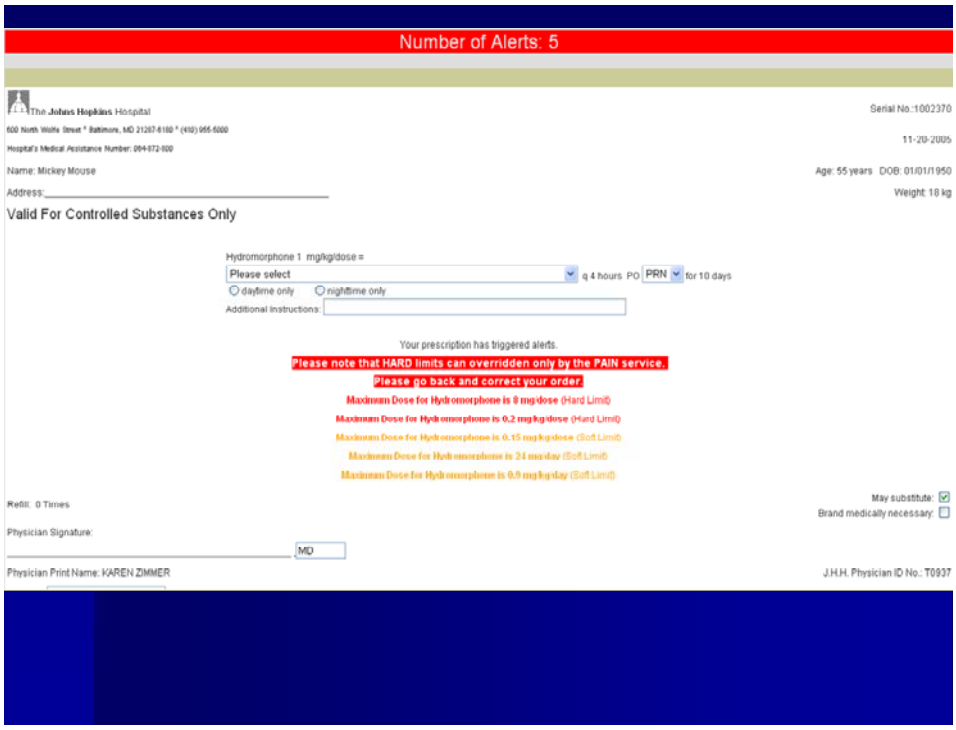
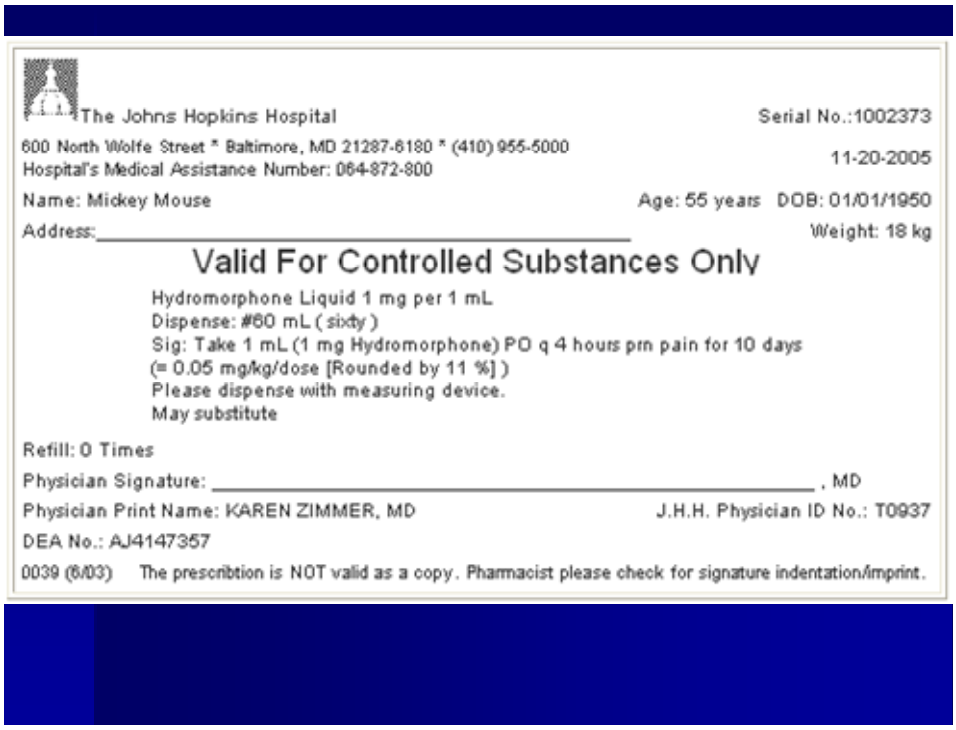


Figure 3: Completed Prescription Generated by the Program



The Johns Hopkins Hospital

Serial No.:1002373

600 North Wolfe Street * Baltimore, MD 21287-6180 * (410) 955-5000
Hospital's Medical Assistance Number: 064-872-800

11-20-2005

Name: Mickey Mouse

Age: 55 years DOB: 01/01/1950

Address:_____

Weight: 18 kg

Valid For Controlled Substances Only

Hydromorphone Liquid 1 mg per 1 mL
Dispense: #60 mL (sixty)
Sig: Take 1 mL (1 mg Hydromorphone) PO q 4 hours prn pain for 10 days
(= 0.05 mg/kg/dose [Rounded by 11 %])
Please dispense with measuring device.
May substitute

Refill: 0 Times

Physician Signature: _____ , MD

Physician Print Name: KAREN ZIMMER, MD

J.H.H. Physician ID No.: T0937

DEA No.: AJ4147357

0039 (6/03) The prescribtion is NOT valid as a copy. Pharmacist please check for signature indentation/imprint.

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