Variability in compounding of oral liquids for pediatric patients: A patient safety concern

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Abstract

Objective: To determine the degree in variation of oral liquid pediatric compounding practices in Michigan pharmacies.

Design: Cross-sectional survey study.

Setting: All types of inpatient and outpatient pharmacies across the state of Michigan, excluding nuclear pharmacies and long-term care facilities.

Participants: 244 Michigan pharmacies.

Intervention: An online survey tool was used to assess the current compounding practices of 147 oral liquid pediatric medications. The survey was e-mailed or faxed to hospitals, chain pharmacies, and independent pharmacies. Pharmacists were also mailed a follow-up postcard, and the Michigan Pharmacists Association publicized the project through its journal and annual meeting.

Main outcome measures: Pharmacy demographics; number of compounding pharmacies; number of medications compounded; awareness of compounding errors; results of compounding errors; and number of concentrations compounded per medication.

Results: The majority of respondents were from outpatient pharmacies, but inpatient and other types of pharmacies were also represented. The majority of participating pharmacies compound fewer than five oral liquid medications per week. Awareness of errors was low overall, with no errors believed to result in permanent harm or death. The number of concentrations compounded per medication ranged from 1 to 9, with the majority of pharmacies compounding more than 3 concentrations per medication.

Conclusion: There is a considerable degree of variation in current oral pediatric liquid compounding practices in Michigan pharmacies. This variability poses a significant risk to patient safety.

Keywords: Patient safety, drug compounding, oral liquids, pediatrics, current pharmacy practices, formulations.

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Children are often unable to swallow tablets or capsules and are thus prescribed oral liquids. Unfortunately, many medications are not commercially available in oral liquid form. In such cases, pharmacists must compound personalized medications.

At the University of Michigan's C.S. Mott Children's Hospital approximately 60% of oral solutions made are unavailable commercially and require compounding. Within the practice of medicine and pharmacy, there is currently no standardization of the final concentrations of these oral liquids. As a result, there may be significant variation in available concentrations of compounded oral liquids, which could potentially lead to medication errors.

For example, a caregiver accustomed to administering a certain volume of medication to a child may not realize that the concentration of the drug compounded at a different pharmacy has changed. The caregiver's administration of the same volume of liquid could thus result in a serious medication error that causes harm to the patient. At Mott Children's Hospital, several medication errors due to nonstandard practices were seen around the prescribing and compounding of oral liquid medicines for pediatric patients.

The Joint Commission noted in a Sentinel Event Alert on preventing pediatric medication errors that pediatric inpatients have an approximately threefold increase in potential adverse drug events compared with adults. The alert suggested limiting the number of concentrations and dose strengths for high-alert medications, and that compounded oral medications should have similar volume concentrations for both inpatient and outpatient use.[1]

On a national level, the Consumer Healthcare Products Association has reported that manufacturers have voluntarily established one standard concentration for single-ingredient liquid formulations of acetaminophen for children younger than 12 years.[2] This has led to the elimination of the infant acetaminophen concentration of 80 mg per 0.8 mL and adoption of an industry-wide standard concentration of 160 mg per 5 mL.

Additionally, the U.S. Food and Drug Administration's Nonprescription Drugs Advisory Committee and Pediatric Advisory Committee have recommended enhanced labeling of all over-the-counter, single-ingredient pediatric acetaminophen products.[3]

These actions promote patient safety through standardization of the concentration of single-ingredient pediatric liquid formulations of acetaminophen. However, this addresses one of many medications currently formulated as an oral liquid for pediatric patients. Despite initiatives to expand commercially available oral liquids for pediatric use, it is likely that compounded products will remain common practice for many years to come.

An article in the *American Pharmaceutical Review* called upon the industry to publish verified, extemporaneous formulations to standardize oral liquid concentrations compounded in pharmacies. The author explained that such formulations would improve the safety of pediatric patients through formulations with standardized doses, adequate bioavailability, safe excipients, and uniform stability.[4] Today, industry-provided formulations rarely exist.

The University of Michigan (UM) Health System and UM College of Pharmacy, in collaboration with the Michigan Pharmacists Association (MPA), initiated a project to standardize oral liquids compounded for pediatric use in Michigan to improve patient safety. The first step in this process was to characterize the current variation in compounding practices for oral liquids in pharmacies throughout the state.

At a Glance

Synopsis: This survey of Michigan pharmacists confirmed that a high degree of variation exists in compounding of oral liquid medications for pediatric patients. Respondents indicated that more than 50% of the relevant survey medicines are compounded in at least 3—and up to 9—different concentrations in pharmacies across the state. Only about 20% of relevant medicines were compounded in a single common concentration.

Analysis: *Transitions in care are associated with patient safety risks. This may be especially true in the pediatric population as many of the oral liquid medicines used in children are not available in commercially manufactured forms and must be compounded in pharmacies. These results are important in helping to quantify the degree of variation and highlighting the potential risk to patients during care transitions that could result from lack of standardization in compounded oral liquid medicines. The findings also provide the basis for the next phase of the initiative, which is to create statewide standards for the prescribing and compounding of these medicines in order to improve safety.*

Objective

The objective of this project was to determine the extent of variation in oral liquid compounding practices before a statewide standardization effort. The results of this phase of the project will be used to inform efforts to develop statewide standards.

Methods

Questionnaire development

Four children's hospitals were contacted (three in Michigan and one in an adjacent state) to provide lists of medications and concentrations compounded for children at the respective institutions. The medications and concentrations were compiled and served as the foundation of a survey developed for use in the study.