Factors Associated With Dispensing Dosage Delivery Devices

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OBJECTIVES A potential cause of medication errors in children is imprecise measurements, particularly using household spoons. There are no regulations requiring dispensing dose delivery devices (DDD) with liquid prescription medications. Local, regional, and national pharmacy practice patterns are largely unknown. This study sought to determine how frequently devices are provided with prescription pediatric liquid medications with instructions for their use at pharmacies in Bronx, New York, and to examine which pharmacy and pharmacist characteristics are associated with reported practices.

METHODS All pharmacies in Bronx, New York, were identified using an online telephone directory. A telephone survey was administered to the senior-level pharmacist that elicited availability of DDDs, whether pharmacy policy regarding dispensing devices existed, the pharmacist's personal practice of dispensing devices, and years in practice.

RESULTS In total, 268 pharmacies were contacted; 214 had free DDDs (79.9%) most of the time, 97.8% had them available to buy, and 160 (59.7%) had no policy regarding dispensing devices. Overall, 199 pharmacists (74.3%) routinely dispensed devices, and 195 (73.3%) demonstrated the use of devices. However, 94 pharmacists (35.3%) recommended using a household spoon to measure correct doses at least some of the time. Pharmacists were less likely to give devices as their years in practice increased.

CONCLUSIONS In our study, many Bronx pharmacies had no policy regarding dispensing DDDs for prescription liquid medications, and dispensing practices varied among pharmacists based on years in practice. If similar trends are found in other areas, standardizing pharmacy policy and pharmacists' practices may decrease morbidity in children due to medication measurement errors.

ABBREVIATIONS DDD, dosage delivery devices

KEYWORDS dosage delivery devices; liquid medications; medication errors

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Introduction

Unintentional medication errors in children are a common but preventable public health problem. One potential cause of liquid medication errors is imprecise measurements by caregivers, particularly using household teaspoons and tablespoons. Several studies have reported that the use of household spoons for administering medications to children is widespread.^{1–3} However, teaspoons and tablespoons are inaccurate measuring devices, and volume capacities vary considerably.^{1–5}

In 2011, the US Food and Drug Administration issued several guidelines to manufacturers of over-the-counter liquid medications, including the recommendation that calibrated dosage delivery devices (DDD) be dispensed with all such medications. Although measuring cups or calibrated droppers are now included with most over-the-counter pediatric liquid medications, there are currently no regulations requiring that DDDs, such as oral syringes or dosing spoons, be dispensed with liquid prescription medications and given instructions for their

use. A recent study by Johnson and Meyers⁶ reported variable dispensing practices for delivery devices in a chain community pharmacy for liquid prescription medications. To our knowledge, no other published studies have focused on local, regional, or national pharmacy practice patterns, which remain largely unknown.

The main objective of this study was to determine how frequently DDDs are provided with prescription pediatric liquid medications along with instructions for their use at pharmacies in Bronx, New York. The secondary objective was to examine whether certain pharmacy or pharmacist characteristics were associated with the reported practice.

Materials and Methods

All pharmacies in Bronx, New York, were identified using an online telephone directory (www.yellowpages.com). Based on census data, the mean income for the zip code where each pharmacy was located was recorded (www.zipatlas.com). A telephone survey consisting of several scripted questions (Table 1) was

Table 1. Survey Questions

1. Does your pharmacy have a policy about dispensing oral medication devices when filling prescriptions for pediatric liquid medications?
2. How often are oral medication devices available for free at your pharmacy? To buy?
3. How often do you dispense oral medication devices when filling prescriptions for pediatric liquid medications?
4. How often do you demonstrate to a parent how to use an oral medication device?
5. Do you ever recommend using household spoons?
6. Do you believe oral medication devices can decrease medication errors?
7. How many years have you been in practice?
8. Instructions on a prescription are written as: "1 1/2 teaspoons every 6 hrs for 7 days." What would you tell the parent?
9. Instructions on a prescription are written as: "7.5 ml every 6 hrs for 7 days." What would you tell the parent?

administered by the primary investigator (EW) to the most senior pharmacist on duty at each pharmacy, who we hypothesized, would be most familiar with that pharmacy's internal policies and practice patterns. If the most senior pharmacist on duty was not available to take the survey at the time of the initial telephone call, the primary investigator arranged an alternate time with that pharmacist to call again. Calls were made Monday through Friday between 9 AM and 4 PM.

The primary investigator first confirmed the name of the pharmacy and noted whether it was part of a chain or privately owned. Survey questions included whether a pharmacy policy existed regarding dispensing DDDs (Yes/No or Don't Know) and the availability of DDDs, either for free or for purchase, a majority of the time. We defined "majority of the time" as at least 75% of the time. Pharmacists were asked if they dispensed DDDs a majority of the time; if they demonstrated the use of DDDs (Yes/No/Sometimes); if they recommended the use of household spoons (Yes/No/Sometimes); and if they believed that the use of DDDs decreased measurement errors by caretakers (Yes/No); and their years in practice. Finally, the primary investigator read 2 scenarios to the pharmacist, 1 scenario describing a prescription written in teaspoon units (i.e., 1.5 teaspoons every 6 hours for 7 days), and the other describing the same prescription written in milliliter units (7.5 mL every 6 hours for 7 days). The pharmacist was asked to explain what dosing instructions he or she would provide to the caretaker with each of the two prescriptions to assess whether the specified dosing units on the prescription would impact on whether or not a dosage delivery device would be dispensed.

Results were analyzed using simple frequencies and descriptive statistics. Categorical variables were analyzed using Chi-square, or Fisher's exact test when appropriate. Data analyses were performed using SPSS 14.0 for Windows Graduate Student Version (SPSS, Inc, Chicago, IL).

The Institutional Review Boards of the Albert Einstein College of Medicine and Jacobi Medical Center approved this study.

Results

Two hundred ninety-three pharmacies were identified using online yellow pages. Of these, 25 had incorrect phone numbers. A total of 268 pharmacies were successfully contacted, and all pharmacists agreed to participate. Among all pharmacies, 57 (21.3%) were chain pharmacies, and 211 (78.7%) were privately owned. The majority of pharmacists had been employed less than 20 years (71.4%). Most pharmacists believed that dosage delivery devices decreased errors (Table 2).

Overall, 199 pharmacists (74.3%) stated they dispensed DDDs a majority of the time, and 195 (73.3%) stated that they always demonstrated how to use the delivery device to the caretaker when dispensing a pediatric liquid medication. These practices were significantly influenced by whether the pharmacist worked at a chain or a privately owned pharmacy (Table 2).

In total, 160 pharmacies (59.7%) had no policy regarding dispensing DDDs. There was no significant difference between chain pharmacies and privately owned pharmacies in terms of having a policy (40.4% versus 39.6%, respectively; $p = 0.26$). However, pharmacists who worked at a pharmacy with a policy were significantly more likely to dispense and demonstrate the use of DDDs and to believe that DDDs decreased errors (Table 2).

Overall, 214 pharmacies (79.9%) had DDDs to give for free a majority of the time. There was no significant difference between chain pharmacies and privately owned pharmacies in terms of having DDDs for free (87.7% versus 77.7%, respectively; $p = 0.1$). Pharmacies with a policy related to DDDs were significantly more likely to have devices available to give for free than pharmacies without a policy (98.1% versus 67.5%, respectively; $p < 0.001$). Almost all the pharmacies (97.4%) had DDDs available for purchase, with no difference between chain and privately owned pharmacies (100% versus 97.1%, respectively; $p = 0.35$).

Pharmacies located in zip code regions with the 5 highest mean income levels were compared to those located in zip code regions with the 5 lowest mean

Table 2. Pharmacist Beliefs and Practices Compared to Pharmacy and Pharmacist Characteristics

	Type of Pharmacy			Pharmacy Has Policy			Pharmacist Employed >20 Yrs		
	Chain (n = 57)	Private (n = 211)	p value	Yes (n = 107)	No (n = 160)	p value	Yes (n = 74)	No (n = 185)	p value
Believe DDDs decrease errors, n (%)	50 (87.7)	148 (70.5)	0.01	100 (93.4)	97 (61.8)	<0.001	40 (54.8)	152 (82.2)	<0.001
Dispense DDDs most of the time, n (%)	51 (89.5)	148 (70.5)	0.004	102 (95.3)	96 (60.4)	<0.001	43 (58.9)	148 (80)	<0.001
Always demonstrate use of DDDs, n (%)	50 (87.7)	145 (69.7)	0.01	97 (92.4)	97 (61)	<0.001	43 (58.9)	144 (78.7)	0.001
Usually recommend house spoons, n (%)	11 (19.6)	83 (39.5)	0.01	18 (16.8)	76 (48.1)	<0.001	39 (53.4)	52 (28.3)	<0.001

DDD, dosage dispensing device

*Denominators differ due to missing data.

income levels. There were no significant differences between pharmacies with respect to having a policy, having DDDs to give for free or to buy, or among pharmacists with respect to their overall practice of dispensing dosage devices.

A total of 94 pharmacists (35.3%) stated they sometimes or usually recommended that a parent use a household spoon to measure correct medication doses (Table 2). In response to the scenarios, 74 pharmacists (27.6%) stated they would recommend that a parent use a household spoon if the prescription was written in teaspoons, and 51 (19.0%) would recommend the use of a household spoon, even if the prescription was written in milliliters.

Pharmacists in practice for less than 20 years were more likely to believe DDDs decreased errors than those in practice more than 20 years (Table 2). Those in practice less than 20 years were also more likely to dispense, recommend, and demonstrate the use of DDDs, and were less likely to recommend a teaspoon or tablespoon (Table 2).

Discussion

Unintentional medication overdoses are responsible for more than 70,000 pediatric visits to emergency departments each year. In 1992, the American Association of Poison Control Centers reported that a common cause of liquid medication dosage errors was teaspoon or tablespoon confusion.⁷ Variability in measured volume capacity of household teaspoons has been reported in many studies, ranging from as little as 1.5 mL to as much as 9 mL.¹⁻⁵ Because pediatric doses for medications are generally weight-based, small variations in measured amounts may result in considerable under- or overdoses. Case reports and data from poison control centers have documented significant morbidity in pediatric patients from inadvertent overdoses using household spoons, as well as worsening illness from underdoses of critical medications.^{5,8,9}

Several studies have shown that caregivers' mea-

surements are more accurate when they use oral syringes to administer liquid medications compared to measuring cups.^{2,4,10} Another recent study reported that parents who used teaspoon or tablespoon units were more likely to make an error in dosage than parents who only used milliliter measurements for both the dose they intended to give and the prescribed dose.¹¹

In May 2011, the Food and Drug Administration finalized voluntary guidelines to industry addressing various issues including the lack of dose devices for orally administered over-the-counter liquid medications and stated that dose devices should be in metric units rather than in teaspoons or tablespoons.¹² Various public health agencies, consumer and patient advocate groups, and academic experts have issued similar recommendations regarding the importance of metric-based doses for all pediatric liquid medications,^{13,14} and the American Academy of Pediatrics has specifically advocated use of metric-based oral syringes for administering liquid medications to children.¹⁴

Our survey of Bronx pharmacies found that almost 60% did not have any policy regarding dispensing delivery devices for prescription pediatric liquid medications. Although most pharmacies had devices to give for free, approximately 25% of pharmacists did not routinely dispense them for liquid medications, and almost 20% of pharmacists stated that they would recommend that caregivers use household teaspoons, even if a prescription was written in milliliters.

We hypothesized a priori that pharmacies in higher income neighborhoods might have had more resources to be able to consistently have DDDs available to dispense for free and that a resulting disparity might have existed in pharmacists' dispensing practices. However, we found no differences in the availability of DDDs or pharmacists' overall dispensing practices based on income level of the neighborhood where the pharmacies were located.

We found that years in practice impacted pharmacists' beliefs and practice with regard to dispensing

devices. We do not know the reason for this observation. However, a few studies examining physician adherence to various current practice guidelines found that those who were more recently trained were more likely to adhere to the guidelines than those who had been out of training for more years.^{15–18} It is possible that there is a similar inverse effect for the pharmacists we surveyed of years out of training with adherence to current recommendations regarding DDDs. However, there are no data specifically focusing on factors that influence practice patterns of pharmacists.

In our study, more than 25% of pharmacists surveyed do not routinely demonstrate the use of an oral syringe when they are dispensing one. McMahon et al¹⁹ found that caregivers who were given verbal instructions as well as a demonstration of the proper use of a measuring device were significantly more likely to give correct doses of liquid medications than those who received only written instructions. Yin et al²⁰ reported improvement in dosage accuracy using a pictogram-based intervention along with a demonstration of the proper use of a measuring device compared with standard instructions only. Another recently published study by Yin et al²¹ demonstrated a significant decrease in dosage errors by parents when they were given advanced counseling strategies in the emergency department or provided with a dosage instrument from the emergency department. Although none of these studies examined teaching strategies in pharmacy settings, it is possible that similar interventions in pharmacies could also be effective. Although such strategies may be time- and resource-consuming, the potential for improving child safety with regard to medication errors is great.

There were several limitations to our study. Because we surveyed pharmacists only in Bronx, New York, our results may not reflect practices in other areas. However, the mean income distribution for all zip codes ranged from below the poverty threshold to higher income brackets, so we believe that the pharmacies we sampled were representative with respect to available resources. Also, only the most senior pharmacist on duty at each pharmacy was surveyed. Other pharmacists might have had different practices and opinions regarding dispensing DDDs. Additionally, we did not collect data regarding the size of each pharmacy with respect to the number of patients served, how many pharmacies were in a particular chain, and how many chains were represented in our sample. Finally, pharmacists' answers might have been influenced by their agreement to participate in the telephone survey. However, the primary investigator assured them of anonymity, and no identifying personal data were collected, to try to minimize this effect.

In our study of Bronx pharmacies, many did not have a policy regarding DDDs for prescription liquid medications. Dispensing practices for giving DDDs varied among pharmacists based on the type of pharmacy

where they worked (chain versus privately owned), and the number of years in practice.

If similar trends are found in other areas, interventions directed at standardizing pharmacy policy and pharmacists' practice may help decrease potentially significant morbidity in children due to medication measuring errors.

ARTICLE INFORMATION

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