

# How Much Antibiotic Suspension Is Enough?

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**ABSTRACT.** *Objectives.* Pilot data suggest that inadequate antibiotic volumes are often dispensed. Study goals were to determine the frequency of inadequate antibiotic volumes dispensed by local pharmacies, develop prescription-writing guidelines to ensure that adequate antibiotic suspension volumes are dispensed, and document the adequacy of verbal/written counseling pharmacists provide.

*Methods.* Sixty-one local pharmacies filled prescriptions for penicillin potassium (PCN; 250 mg/5 mL [5 mL orally 3 times daily for 10 days]) and Bactrim (trimethoprim-sulfamethoxazole [TMP-SMX] 5 mL orally twice daily for 10 days). The prescriptions noted only to "dispense a 10-day supply." Volumes were measured first as total amount dispensed and then into total doses dispensed. Written/verbal instructions were documented.

*Results.* The volume of PCN dispensed was  $195 \pm 25$  mL (range: 105–222 mL) for an average of 29.4 doses, where 30 doses were needed. TMP-SMX dispensed had a volume of  $107 \pm 5$  mL (range: 98–120 mL) resulting in an average of 16.5 doses, where 20 doses were needed. Twenty pharmacies (33%) did not dispense a measuring device. Verbal counseling by the pharmacist and written instructions were not uniformly given.

*Conclusions.* We suggest calculating the actual volume needed plus an additional 10% to 30% of volume (depending on the viscosity). The prescription should also request a medication-measuring/administering device. Patient counseling and instruction should be expanded. *Pediatrics* 2000;106(1). URL: <http://www.pediatrics.org/cgi/content/full/106/1/e10>; *antibiotic dispensing, suspensions, measuring devices.*

ABBREVIATIONS. PCN, penicillin potassium; TMP-SMX, trimethoprim-sulfamethoxazole; SD, standard deviation.

Antibiotics prescribed for infants and young children are usually dispensed as oral suspensions because of the child's inability to swallow tablets or capsules; unavailability of certain antibiotics in a chewable tablet form; and the discomfort, expense, and associated risk of antibiotic injections. A prescription should also specify the medication type, formulation, concentration, dosage, dosing frequency, and duration of the treatment course. The exact antibiotic suspension volume to be dispensed

may be stipulated by the physician or left to the pharmacist.

A pilot study at this center suggested that an inadequate medication volume was frequently dispensed by pharmacists. On average, the children in this pilot study received only 8 of 10 days of antibiotic therapy. This same pilot study also identified potential problems related to medication instructions given to parents by the dispensing pharmacist.

The purposes of this study were to: 1) objectively determine the frequency of inadequate antibiotic suspension dispensed by local pharmacies; 2) establish guidelines for prescription writing that will facilitate adequate dispensing of antibiotic suspension volumes; and 3) document adequacy of verbal and written counseling provided by pharmacists.

## METHODS

Two frequently prescribed antibiotic suspensions were studied—penicillin as generic penicillin potassium oral suspension (PCN; 250 mg/5 mL) and trimethoprim sulfamethoxazole (TMP-SMX) as Bactrim oral suspension (200 mg SMX and 40 mg TMP/5 mL). Both prescriptions were written for a specified volume of antibiotic suspension for each dose and treatment duration—ie, 5 mL by mouth 3 times daily for 10 days for PCN and 5 mL by mouth twice daily for 10 days for TMP-SMX. Prescription instructions to the pharmacist specified to "dispense a 10-day supply."

Prescriptions were written using study patient names and signed by 1 of the investigators (L.B.D.). Individual pharmacies were not informed of the study. Review by committee A, the Institutional Review Board for Research Involving Human Subjects, was solicited but waived by the committee chairperson because no human subjects were directly involved. The Iowa Board of Pharmacy Examiners was also informed of our study.

Study personnel took prescriptions for both medications to 78 registered pharmacies in the 3-county sampling area. Pharmacies were noted as rural or urban and also as chain or independent. Duplicate copies of each prescription were entered in the study file. Study personnel returned later the same day to pick up filled prescriptions and to document pharmacist instruction/counseling offered or given regarding the study medications. Medications were stored under refrigeration until volume analysis was performed and this occurred before the medication expiration date.

Analysis of the medications prescribed included several steps. First, both PCN and TMP-SMX prescriptions were removed from the refrigerator, and the TMP-SMX was allowed to approach room temperature before analysis. Prescription-labeling information, such as generic or brand name of antibiotic, volume dispensed, and prescription information, was recorded for each medication.

Second, the actual volume of antibiotic dispensed was measured using the measuring techniques that parents would normally use at home. For PCN: 1) The bottle was well shaken and then the contents were poured into a graduated cylinder. The total volume of PCN was recorded. 2) A small amount (~ 10–15 mL) of PCN suspension was poured into a 30-mL medicine cup from which 5 mL of PCN was withdrawn via a 6-mL syringe. 3) The PCN 5-mL aliquot was discarded and 1 dose of medication recorded on the flow sheet. 4) The remaining PCN suspension was returned to the graduated cylinder. 5) The medicine cup and syringe were rinsed and dried. This procedure was repeated until

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the graduated cylinder was empty. Quantitation of the TMP-SMX suspension was performed in a similar manner.

As a cross-check, 2 of the investigators independently determined the actual amount of PCN and TMP-SMX needed to complete a 10-day antibiotic course using the same technique described above. The investigators started with a volume of 240 mL of PCN 250 mg/5 mL and 150 mL of TMP-SMX. The volume remaining after measuring 30 doses of PCN and 20 doses of TMP-SMX was subtracted from the volume initially measured in the graduated cylinder to give the amount of antibiotic needed in these test bottles.

Directions written on the prescription bottle labels, such as shake well, etc, were recorded on summary sheets for each antibiotic. If the pharmacist had dispensed any devices (ie, syringe, medicine cup, or spoon) to facilitate measuring and/or administration of the antibiotic suspension, these items were also noted on study summary sheets. Prescription costs were noted as well.

The checklist of pharmacist counseling/instruction completed by study personnel at prescription retrieval were checked and recorded for comparison with OBRA 90 guidelines (Des Moines, IA).<sup>9</sup>

### Statistics

Sample size of registered pharmacies was determined:

$$n = \frac{(1.96)^2(P)(1 - P)}{d^2}$$

$$n = \frac{(1.96)^2(2.69)(.731)}{(.1)^2}$$

$n = 75.54$  for .1 margin of error.

Descriptive statistics were used with results reported as means  $\pm$  standard deviation (SD) and also as range, for clarity.

### RESULTS

All 78 licensed pharmacies in Johnson, Linn, and Iowa counties were studied. Of these, prescriptions were filled at 61 pharmacies. The remaining 17 pharmacies were unable to fill the study prescriptions. The primary reasons cited were not open to the public, ie, employees only, in-home care patients only, health plan members only, or inmates only. Pharmacies ( $n = 61$ ) were classified as rural (9), urban (52), chain (35), and independent (26). At 41 of the 61 sites, pharmacists rather than support staff dispensed the medications to the patient.

Thirty of the 61 (49%) pharmacies asked whether the patient wanted generic medications. Pharmacists dispensed PCN as 6 different brand names. The volume (mean  $\pm$  SD) of PCN dispensed was  $195 \pm 25$  mL (range: 105–222 mL). The mean number of PCN doses was 29.4. Forty-six pharmacies (75%) dispensed 30 or more doses. The volume of PCN needed to complete the 10-day course, determined by the investigators' test bottle evaluation, was 160.5 mL for a 30-dose treatment course.

Bactrim was dispensed as 9 brand names and all but 1 were generic. The volume (mean  $\pm$  SD) of TMP-SMX dispensed was  $107 \pm 5$  mL (range: 98–120

mL). The mean number of doses obtained from this volume was only 16.5. No pharmacy dispensed the full 20 doses needed to complete the prescribed treatment course. The volume of TMP-SMX needed, shown by the investigators' test bottle evaluation, was 130 mL for the 20 doses.

The prescriptions did not specify the dispensing of an accurate measuring device for administration of the antibiotic suspensions. Of the 61 pharmacies, 24 (39%) dispensed medicine spoons, 17 (28%) dispensed medication syringes, and 1 (2%) dispensed a measuring medication cup. One pharmacy dispensed both a medication spoon and a syringe. Twenty (33%) pharmacies did not dispense any device to measure/administer the antibiotic suspensions.

Cost varied markedly among the sampled pharmacies (Table 1).

Instructions to the patient/family could be given in a variety of ways, ie, ancillary labels placed on the bottle, verbal instruction by the pharmacist, or written drug information sheets given to the patient/family. Each prescription bottle for PCN and TMP-SMX was checked for specific instructions and the results are summarized in Table 2.

Patient/parents also received medication information via verbal instructions from the dispensing pharmacist/or pharmacy technician. Eighty-two percent ( $n = 50$ ) received advice on proper storage of their medications. Eighty-two percent ( $n = 50$ ) of pharmacists asked about allergies. The dosage form, dose, route of medication administration, and duration of therapy were reviewed with 49 (80%) of the study personnel retrieving the prescriptions. Special directions and precautions for preparation, administration, and use by the patient were frequently recorded ( $n = 47$ ; 77%). Forty-seven (77%) of participating pharmacies reviewed the name and description of drug with the individual picking up the prescription. Eleven (18%) asked about other medical conditions. Rarely provided ( $n = 4$ ; 7%) was verbal counseling about potential severe or adverse side effects or interactions and therapeutic contraindications that may be encountered, including their avoidance and the action required if they should occur. No one received verbal counseling for techniques for self-monitoring drug therapy. None of the pharmacists addressed the intended use of the drug, if known, and expected action. Counseling was not provided for prescription refill information or the action to be taken in the event of a missed dose. No pharmacist comments relevant to the individual's drug therapy, including any other information peculiar to the specific patient or drug, were noted.

**TABLE 1.** Cost of Antibiotics by Pharmacy Group (Mean  $\pm$  SD)

	All Pharmacies $n = 61$	Rural $n = 9$	Urban $n = 52$	Chain $n = 35$	Independent $n = 26$
PCN	\$9.00 $\pm$ \$2.29 (range: 2.24–13)	9.53 $\pm$ 1.54	8.96 $\pm$ 2.39	8.48 $\pm$ 2.06	9.70 $\pm$ 2.44
Bactrim	\$8.01 $\pm$ \$2.09 (range: 1.36–13.95)	7.33 $\pm$ 1.40	8.15 $\pm$ 2.17	7.93 $\pm$ 1.88	8.12 $\pm$ 2.38

**TABLE 2.** Prescription Information on Bottle Labels

PCN n = 61	TMP-SMX n = 61
Shake well, 56 (92%)	Shake well, 59 (97%)
Refrigerate, 60 (98%)	Finish all unless otherwise directed, 17 (28%)
Finish all unless otherwise directed, 13 (21%)	Drink with plenty of water, 43 (70%)
Discard after 14 d, 53 (87%)	Avoid prolonged or excessive exposure to direct or artificial sunlight, 24 (39%)
Take on empty stomach 1 h before or 2–3 h after meal unless otherwise directed, 9 (15%)	Discard after (date), 3 (5%)
Keep tightly closed, 1 (2%)	Do not refrigerate, 4 (7%)
Avoid fruit juice, 1 (2%)	Take with food, 0 (0%)
Do not freeze, 4 (7%)	If upsets stomach, take with crackers, bread or small meal, 1 (2%)

Sheets of written instructions regarding the prescription antibiotics were included by 32 (52%) of the participating pharmacies. These instructions varied from a brief few sentences to extensive paragraphs.

### DISCUSSION

Measuring and administering antibiotic suspensions to infants and young children can be inaccurate depending on the method used (teaspoon, syringe, measuring spoon, etc) or futile if the medication is spit out or spilled. Nonetheless, completion of the entire treatment course is the goal and essential for certain infections, such as group A  $\beta$ -hemolytic streptococcus.<sup>1–5</sup> As suggested by our pilot study and confirmed in this study, antibiotic suspension volumes dispensed are frequently not adequate to complete the prescribed treatment course. To a large extent, this was dependent on the physical characteristics of the specific antibiotic. For the 6 varieties of PCN suspensions, all were fairly uniform and watery in character. For the 9 TMP-SMX products, however, variability in texture and creaminess was obvious. The more viscous the oral antibiotic, the greater the likelihood of running out of medication prematurely because of medication adhering to the walls of the medicine cup, syringe, and medicine bottle. This could be especially problematic if parents refrigerated the TMP-SMX as the pourability decreased as the medication cooled. For sticky, viscous TMP-SMX suspensions, it was necessary to receive 130 mL, not 100 mL, to complete the 20-dose treatment regimen—a 30% increase above calculated volume. For watery textured PCN, 160.5 mL were needed instead of 150 mL to complete a 30-dose treatment plan, a 7% increase. Our study has shown that writing “dispense 10 days supply” frequently results in inadequate volumes to complete a 10-day treatment plan. Families may then obtain additional antibiotic suspension with a second dispensing/medication fee or not complete the recommended 10-day treatment at all.

The pharmacist is responsible for dispensing the correct medication in an appropriate volume to complete the treatment course and for instructing the parent/patient on important medication related issues, ie, preparation, storage, and side effects. Prescription-dispensing errors may include wrong drug

dispensed, wrong formulation dispensed, medication dispensed to wrong patient, wrong dosage dispensed, absent drug name, absent directions, and incorrect concentration of medicine.<sup>6–8</sup> One study reports inadequate drug quantity dispensed secondary to a labeling error. Careful instructions by the pharmacist may detect some of these prescription errors and also promote the proper administration and storage of the antibiotic suspensions, which further decreases wastage. Nearly two thirds of the pharmacies dispensed a device for medication dispensing. Most pharmacies also listed directions on the medication bottles that varied in completeness. For example, nearly all PCN prescriptions had refrigerate instructions, but for TMP-SMX, only 4 of 61 reminded the parent not to refrigerate this already thick suspension.

Guidelines were previously established by the Iowa Board of Pharmacy Examiners in 1993 to ensure that patients/parents received information/instruction about prescription medications they receive.<sup>9</sup> As demonstrated in this study, verbal instructions from pharmacist to parent/patient are relatively focused and brief. Thirty-two pharmacies (52%) distributed written instruction sheets for parent/patient use that may address instructions/information not covered verbally.

Our study measured the total volume of antibiotic suspension dispensed and the total number of doses using a set measuring regimen free of distractions. We did not take into consideration additional medication volumes needed to replace the spit-out, vomited-up, batted-away, or spilled doses.

Our study identified several problems in dispensing medication suspensions that can be fairly easily remedied. To ensure that pediatric patients receive adequate medication volumes, we recommend that the physician calculate the volume of antibiotic that is needed to complete the treatment course and include 10% to 30% additional volume, depending on the viscosity of the medication. The physician should also request that a medication-measuring/administering device (syringe or medication spoon) be dispensed to improve accuracy and prevent waste. The physician could further help the patient/family by reviewing the reasoning for a specific antibiotic to be used, checking for allergies, and explaining possible adverse drug reactions and interactions that may not be done by the pharmacist. Pharmacists should reinforce the medication use instruction sheet and counsel on appropriate medication storage.

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