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## Changes in Provider Perceptions and Practices Regarding Dosing Units for Oral Liquid Medications

Jennifer N. Lind, PharmD, MPH, MBA<sup>a</sup>, Maribeth C. Lovegrove, MPH<sup>a</sup>, Ian M. Paul, MD, MSc<sup>b</sup>, H. Shonna Yin, MD, MSc<sup>c</sup>, Daniel S. Budnitz, MD, MPH<sup>a</sup>

<sup>a</sup>Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, 1600 Clifton Road NE, Atlanta, GA, USA 30329

<sup>b</sup>Departments of Pediatrics and Public Health Sciences, Penn State College of Medicine, 700 HMC Crescent Road Hershey, PA, USA 17033

<sup>c</sup>Departments of Pediatrics and Population Health, New York University Grossman School of Medicine, 550 First Avenue, New York, NY, USA 10016

### Abstract

**Objective:** A 2015 survey of primary care providers (PCPs) found that while many believed that milliliter (mL)-only dosing was safest for oral liquid medications, few would use mL alone in dosing instructions. Since 2015, many recommendations have promoted “mL-only” dosing. In 2019, a follow-up survey was conducted to assess if PCP perceptions and practices have changed.

**Methods:** Pediatricians, family medicine physicians, nurse practitioners, and internists participating in the 2015 and 2019 DocStyles cross-sectional, web-based surveys were asked about their perceptions and practices regarding dosing units for oral liquid medications.

**Results:** In 2019, among 1392 respondents, the proportion of PCPs who reported they believed using mL-only is the safest dosing instruction ranged from 55.1% of internists to 80.8% of pediatricians. While fewer PCPs believed patients/caregivers prefer dosing instructions in mL-only (23.9% of nurse practitioners to 48.4% of pediatricians), more held this belief in 2019 compared to 2015; pediatricians had the greatest absolute increase (+14.4%) and family medicine physicians had the smallest increase (+1.3%). While 61.6% of pediatricians reported they would use mL-only dosing, only 36.0% of internists, 36.6% of nurse practitioners, and 42.5% of family medicine physicians reported they would do so. After controlling for age, gender, region, and specialty, 2019 PCP survey participants were more likely to report that they would use mL-only dosing compared to 2015 participants (adjusted odds ratio 1.51, 95% confidence interval 1.29–1.77).

**Conclusions:** Broader educational efforts may be necessary to reach non-pediatricians, to encourage prescribing and communication with patients/caregivers using mL-only dosing.

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**Corresponding author:** Jennifer N. Lind, PharmD, MPH, MBA, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, 1600 Clifton Rd NE, Mailstop H16-3, Atlanta, GA 30329-4027, jlind@cdc.gov, 404-498-4339.

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**Conflict of Interest Statement:** None declared

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## Keywords

oral liquid medications; dosing units; primary care providers; milliliters

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## Introduction

Liquid medications are involved in more than 80% of pediatric medication errors that occur out-of-hospital,<sup>1, 2</sup> with parental/caregiver confusion between different volumetric units of measure being a leading cause.<sup>3</sup> Using metric units (i.e., milliliters [mL]) in dosing instructions and on dosing devices for oral liquid medications, and avoiding inclusion of other dosing units, can prevent caregiver dosing errors.<sup>4</sup> Studies have demonstrated that parents and other caregivers, including those with low literacy, are familiar with mL units, and can safely and accurately dose medications using mL alone and make fewer errors compared to dosing using teaspoons.<sup>5-7</sup>

While reasons for reported perceptions and practices were not assessed, a 2015 survey of primary care providers (PCPs) in the U.S. found that many reported that using mL alone was safest for dosing oral liquid medications, but only about one-third would prescribe that way.<sup>8</sup> Since 2015, several policies and recommendations promoting the importance of using “mL-only” dosing units for oral liquid medications have been released.<sup>9-20</sup> Therefore, in 2019 a follow-up survey was conducted to assess if there have been changes in PCP perceptions and practices regarding dosing units for oral liquid medications.

## Methods

Data were collected through DocStyles, an annual Web-based, cross-sectional survey conducted by Porter Novelli that focuses on health-related attitudes and practices of PCPs in the U.S.<sup>21</sup> The 2015 DocStyles survey was conducted from June 4-23, 2015 and the 2019 survey from October 3-November 4, 2019. Both surveys included pediatricians, family medicine physicians, nurse practitioners (NPs), and internists. Target sample sizes were the same for the 2019 survey, except that physician assistants (PAs) were added and combined with NPs. During both survey years, PCPs who participated in the DocStyles surveys were asked which unit of measurement (teaspoons (tsp), tablespoons, mL, both mL and tsp, or another unit of measure) they: 1) think is safest for dosing oral liquid medications; 2) think patients/caregivers prefer; and 3) would actually use in instructions for dosing oral liquid amoxicillin (1 tsp, 5 mL, 1 tsp (5 mL), 5 mL (1 tsp), or none of these). Detailed survey methods were published previously.<sup>8, 21</sup> Briefly, eligible PCPs practiced in the United States, actively saw patients, worked in an individual, group, or hospital practice, and had practiced medicine for at least three years. Demographic information of respondents was collected, including age, gender, race, region, specialty, whether pediatric patients (aged 17 or younger) were treated, and number of years in practice. No individual identifiers were included in the database and so this study was determined to be exempt from institutional review board approval.

Changes in perceptions and practices regarding dosing units for oral liquid medications from 2015 to 2019 were calculated across specialties. Logistic regression was used to assess the

effects of age, gender, region, specialty, and survey year on prescribing practices. PAs were excluded from all analyses since they were not included in the 2015 survey. Analyses were conducted with SAS 9.4.

## Results

A total of 1500 PCPs participated in the 2019 DocStyles survey, a response rate of 65.3%. After excluding PAs (n=108), 1392 PCPs remained in the survey cohort. The mean provider age (49.1 years) and number of years in practice (18.2) was similar across specialties [Table 1] and comparable to the 2015 survey (46.1 years and 15.5 years, respectively). Across specialties, participating PCPs in 2019 were most frequently males (61.2%; except NPs [12.7% male]), White (68.0%), and from the South (34.1%). In 2019, all pediatricians (100%) and the majority of family medicine physicians (92.8%) reported that they had treated children (aged 17 years); however, only 34.5% of internists had treated children.

In 2019, the proportion of PCPs who reported that using mL-only is safest for dosing oral liquid medications ranged from 55.1% of internists to 80.8% of pediatricians [Table 2]. NPs had the greatest absolute increase since 2015 in respondents reporting that mL-only is safest (+7.4%), while the proportion of pediatricians reporting so remained the same (80.8%).

In 2019, most PCPs responded that patients/caregivers prefer instructions that include spoon-based units alone or together with mL (67.9% among PCP respondents). A minority of PCPs reported that they thought patients/caregivers prefer dosing instructions in mL-only (ranging from 23.9% of NPs to 48.4% of pediatricians). Pediatricians had the greatest absolute increase since 2015 (+14.4%), while the increase among other PCP specialties was substantially smaller (ranging from +1.3% of family medicine physicians to +3.2% of NPs).

In 2019, the proportion of PCPs who reported that they would prescribe oral liquid amoxicillin using mL-only increased for all PCP specialties since 2015, ranging from 36.0% of internists to 61.6% of pediatricians. NPs and family medicine physicians had the greatest absolute increase (+8.7% and +8.5%, respectively), but fewer than half would prescribe using mL-only (36.6% and 42.5%, respectively). After controlling for age, gender, region, and specialty, 2019 PCP survey participants were more likely to report that they would use mL-only in amoxicillin dosing instructions compared to 2015 participants (adjusted odds ratio [aOR] 1.51, 95% confidence interval [CI] 1.29–1.77). Pediatricians and family medicine physicians were more likely to report that they would use mL-only in instructions than internists (aOR 3.28, 95% CI 2.62–4.12 and aOR 1.25, 95% CI 1.03–1.51, respectively), while NPs were not (aOR 1.04, 95% CI 0.79–1.37). Younger PCPs (25–39 years of age) were more likely to report that they would use mL-only than older PCPs (>59 years) (aOR 2.68, 95% CI 2.05–3.50). There was no significant difference between female and male PCPs in reporting preference for mL-only in dosing instructions (aOR 0.89, 95% CI 0.75–1.06).

## Discussion

Overall, from 2015 to 2019 perceptions and practices of PCPs began to shift from spoon-based dosing to mL-only dosing instructions, but considerable room for improvement

remains. As in 2015, pediatricians in 2019 continued to be more likely than other PCPs to report prescribing using mL-only instructions, but family medicine physicians, NPs, and internists all reported larger increases in prescribing using mL-only instructions since 2015. This increase, and the finding that younger PCPs were more likely to report that they would use mL-only in 2019, may be the result of numerous standards, guidelines, and policy statements that were issued from 2014 to 2019 by professional organizations (i.e., American Academy of Pediatrics [AAP], American Pharmacists Association, American Academy of Family Physicians, American Medical Association), safety organizations (i.e., National Council for Prescription Drug Programs, Consumer Healthcare Products Association, United States Pharmacopeia), and federal health entities (i.e., Food and Drug Administration, Office of the National Coordinator for Health Information Technology) that promote and facilitate the use of mL-only on dosing instructions and devices for oral liquid medications.<sup>2, 9, 10, 14-20, 22</sup>

A recent study by Rungvivatjarus and colleagues found that a prominent factor affecting parental medication management in underserved communities was a knowledge/skill gap and that parents wanted simplified terminology and digestible information.<sup>23</sup> However, despite studies demonstrating that parents/caregivers of all literacy levels are familiar with mL units and make fewer errors when dosing medications using mL-only, over two-thirds of 2019 PCP survey respondents in this study still believed that patients/caregivers prefer instructions that include spoon-based units alone or together with mL. Moving forward, the increase in the perception that patients/caregivers prefer mL-only instructions was substantially higher among pediatricians than other specialties, suggesting that prior studies<sup>5-7</sup>, professional guidelines, training differences, and/or more frequent interactions with and feedback from families of young children may have had an effect on changing pediatricians' perceptions during this time period and that broader dissemination may be necessary to reach providers in other specialties, such as family medicine physicians and internists. While nearly all the family medicine physicians who participated in the 2019 survey had treated children (92.8%), only 42.5% reported that they would use mL-only in dosing instructions.

In November 2021, AAP released a new policy statement which translates recommendations for mL-only prescribing into concrete actions, including recommendations for improving communication with patients/caregivers regarding appropriate dosing units, encouraging use of standardized dosing tools with oral liquid medications that are the optimal size for the dose volume prescribed, and providing continuing education materials for providers.<sup>2</sup> Nonetheless, there remains a need to disseminate the findings to other specialties. Now that Electronic Health Record certification criteria limit electronic prescribing of oral liquid medication to mL-only<sup>14</sup> and United States Pharmacopeia standards direct manufacturers to remove non-metric dosing/administration devices for all oral liquid medications,<sup>16</sup> all provider specialties will need to adapt to using mL-only when prescribing and dispensing oral liquid medications. Similar efforts to those of the AAP may be needed to encourage changes in their prescribing practices.

There were limitations to this study. First, the DocStyles sample includes only PCPs who were part of the SERMO Medical Panel which may not be representative of all PCPs in the

U.S. Second, similarly, although the 2015 and 2019 samples were drawn from panels with very similar participant characteristics, changes across years could be related to changes in survey participants. Third, the data were self-reported and are subject to reporting biases related to the provider's perceptions and practices. Fourth, the 2021 AAP policy statement/toolkit were released after the 2019 survey was conducted. Future surveys may be needed to assess further changes in PCP perceptions and prescribing practices. Lastly, as with the 2015 survey, reasons for reported perceptions and practices were not specifically assessed. Understanding the reasons for PCP perceptions/practices could help inform interventions.

To reduce medication errors it is also important to raise parental/caregiver awareness of metric unit dosing. There is a need for increased availability of "off the shelf" dosing devices with mL-only markings as well as encouragement to dispense devices with mL-only markings. To help ensure accurate administration, clinicians should demonstrate oral liquid dosing using an appropriate device (e.g., oral syringes or dosing cups) with mL-only markings that match the dosing instructions and have patients/caregivers teach-back dose measurements and frequency.<sup>23-25</sup> Finally, updating healthcare organizations' websites and patient/caregiver materials with dosing guidance in mL and images of mL-only dosing devices can also help increase familiarity with mL-only dosing and facilitate PCP adoption of metric dosing for oral liquid medications.

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**What's New:**

As in 2015, pediatricians in 2019 continued to be more likely than other primary care providers to report prescribing using mL-only. Broader educational efforts may be necessary to reach non-pediatricians, to encourage prescribing and communication with patients/caregivers using mL-only dosing.



**Table 1.**

Respondent Characteristics, DocStyles Survey 2019

Characteristics	Provider Specialty					
	Internist		Family Medicine		Pediatrician	
	n	%	n	%	n	%
<b>Age</b>						
25-39 years	126	21.5	83	20.1	41	16.4
40-49 years	196	33.5	158	38.2	76	30.4
50-59 years	156	26.6	96	23.2	66	26.4
>59 years	108	18.4	77	18.6	67	26.8
<b>Gender</b>						
Male	421	71.8	268	64.7	145	58.0
Female	165	28.2	146	35.3	105	42.0
<b>Race</b>						
White	345	58.9	298	72.0	182	72.8
Black or African American	16	2.7	18	4.4	13	5.2
Asian	184	31.4	72	17.4	45	18.0
Other	41	7.0	26	6.3	10	4.0
<b>Region</b>						
Northeast	161	27.5	84	20.3	70	28.0
Midwest	121	20.7	91	22.0	47	18.8
South	186	31.7	147	35.5	87	34.8
West	118	20.1	92	22.2	46	18.4
<b>Treats Children *</b>						
Yes	202	34.5	384	92.8	250	100.0
No	384	65.5	30	7.3	0	0.0
<b>Time in Practice</b>						
<10 years	123	21.0	82	19.8	34	13.6
10-19 years	227	38.7	168	40.6	93	37.2
>19 years	236	40.3	164	39.6	123	49.2
<b>Total<sup>±</sup></b>	<b>586</b>	<b>100.0</b>	<b>414</b>	<b>100.0</b>	<b>250</b>	<b>100.0</b>
					<b>142</b>	<b>100.0</b>

\* Refers to ever treating patients aged 17 years or younger.

Percentage totals may not add to 100.0% due to rounding.

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Changes in Perceptions and Practices Regarding Dosing Units for Oral Liquid Medications by Provider Specialty, DocStyles Survey 2015 and 2019

Table 2.

Perceptions and Practices Questions	Provider Specialty											
	Internist			Family Medicine			Pediatrician			Nurse Practitioner		
Which unit(s) do you think are the safest to use in dosing instructions for oral liquid medications?	2015 n (%)	2019 n (%)	% Difference	2015 n (%)	2019 n (%)	% Difference	2015 n (%)	2019 n (%)	% Difference	2015 n (%)	2019 n (%)	% Difference
	97 (18.1)	70 (12.0)	-6.1	63 (13.6)	41 (9.9)	-3.7	12 (4.8)	3 (1.2)	-3.6	38 (15.1)	8 (5.6)	-9.5
	44 (8.2)	23 (3.9)	-4.3	17 (3.7)	6 (1.5)	-2.2	1 (0.4)	1 (0.4)	0.0	6 (2.4)	1 (0.7)	-1.7
	269 (50.3)	323 (55.1)	+4.8	278 (59.8)	261 (63.0)	+3.2	202 (80.8)	202 (80.8)	0.0	137 (54.6)	88 (62.0)	+7.4
	120 (22.4)	169 (28.8)	+6.4	104 (22.4)	104 (25.1)	+2.7	35 (14.0)	44 (17.6)	+3.6	68 (27.1)	45 (31.7)	+4.6
	5 (0.9)	1 (0.2)	-0.7	3 (0.7)	2 (0.5)	-0.2	0 (0.0)	0 (0.0)	0.0	2 (0.8)	0 (0.0)	-0.8
Which unit(s) do you think your patients or their caregivers prefer in dosing instructions for oral liquid medications?	210 (39.3)	228 (38.9)	-0.4	190 (40.9)	162 (39.1)	-1.8	91 (36.4)	69 (27.6)	-8.8	112 (44.6)	51 (35.9)	-8.7
	73 (13.6)	45 (7.7)	-5.9	26 (5.6)	13 (3.1)	-2.5	4 (1.6)	2 (0.8)	-0.8	18 (7.2)	8 (5.6)	-1.6
	133 (24.9)	157 (26.8)	+1.9	140 (30.1)	130 (31.4)	+1.3	85 (34.0)	121 (48.4)	+14.4	52 (20.7)	34 (23.9)	+3.2
	114 (21.3)	153 (26.1)	+4.8	106 (22.8)	107 (25.9)	+3.1	70 (28.0)	58 (23.2)	-4.8	67 (26.7)	49 (34.5)	+7.8
	5 (0.9)	3 (0.5)	-0.4	3 (0.7)	2 (0.5)	-0.2	0 (0.0)	0 (0.0)	0.0	2 (0.8)	0 (0.0)	-0.8
	62 (11.6)	44 (7.5)	-4.1	56 (12.0)	42 (10.1)	-1.9	16 (6.4)	18 (7.2)	+0.8	24 (9.6)	5 (3.5)	-6.1
How would you write the dose amount, instructions for oral liquid amoxicillin?	159 (29.7)	211 (36.0)	+6.3	158 (34.0)	176 (42.5)	+8.5	142 (56.8)	154 (61.6)	+4.8	70 (27.9)	52 (36.6)	+8.7
	174 (32.5)	164 (28.0)	-4.5	133 (28.6)	80 (19.3)	-9.3	47 (18.8)	29 (11.6)	-7.2	86 (34.3)	34 (23.9)	-10.4
	122 (22.8)	155 (26.5)	+3.7	112 (24.1)	112 (27.1)	+3.0	45 (18.0)	47 (18.8)	+0.8	62 (24.7)	50 (35.2)	+10.5
	18 (3.4)	12 (2.1)	-1.3	6 (1.3)	4 (1.0)	-0.3	0 (0.0)	2 (0.8)	+0.8	9 (3.6)	1 (0.7)	-2.9