



Perceptions about oral liquid medication dosing devices and dosing errors by caregivers of hospitalized children

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ABSTRACT

Objective: To evaluate oral liquid medication dosing errors in pediatric patients by his/her caregivers before and after educational intervention and perception about liquid oral medication measuring devices. **Material and methods:** This was a prospective and experimental study carried out at paediatric ward, Jivraj Mehta hospital Ahmedabad, Gujarat. Dosing measurement accuracy of the parents/guardian was evaluated by proposing them to select different measuring devices (traditional /manual kitchen spoon, scaled cup, syringes etc.) to measure liquid dose of selected liquid medicine. Frequency of preference and ability to measure accurate liquid dose i.e. 5ml were evaluated in pre and post education phase. Likert scale was used to rate the response while % of measuring error was calculated for change in measurement of liquid before and after education. **Results:**Total 128 respondents participated in study. Respondents' use of dosing cup (n=116) outnumbered the kitchen spoon (n=2) and oral Syringe (n=10). There was a significant decrease in mean medication error post education compared to pre education (2.23, 7.50, $p < 0.0001$). **Conclusion:** Parents/caregivers were more likely to measure an acceptable dose with calibrated dosing cup and cap of the bottle as compared to other measuring devices. Educational intervention is essential to improve liquid dose measurement errors.

KEYWORDS: Paediatric, dosing error, liquid oral medication, measuring devices.

1. INTRODUCTION:

Oral liquids are often the dosage form of choice for young children or adult patients who have difficulty in swallowing because of their ease of administration. Also, with weight-based dosing commonly used in the paediatric population, liquid medication allows for the enhanced ability to determine individualized dosages. Their efficacy and effectiveness depend on the right dosing. The dose in these products is defined and measured in terms of a such volume of the product. With the advent of modern medicine, household spoons were identified as standards used for measuring the doses of oral liquid medications, where the teaspoonful, dessertspoonful and tablespoonful were produced and accepted to measure 5 ml, 10 ml and 15 ml of liquid product respectively. Many parents or caregivers are inexperienced in administering liquid medication, resulting in possible under dose or overdose medication errors.^{[1][2]}

These errors including inaccurate dosing as well as non-adherence to medication regimens, place children at risk of morbidity and mortality. Mis dosing is prevalent with 50% or more caregivers either measuring wrong dose or reporting having given a dose of liquid

medication outside the recommended range, having implications for treatment failure and drug resistance.^[3]

The delivery of liquid preparations is susceptible to several dosage errors associated with the dosing device. Household teaspoons, the volumes of which have been shown to range from 2-9 ml are particularly poor measuring devices. Unacceptable levels of inaccuracies in administering liquid medication by household teaspoons were described by the American Academy of Pediatrics Committee on Drugs in 1975. Since then several calibrated liquid medication dosing devices have been developed including measuring spoons, cups and syringes. The use of such devices would assure adequate therapeutic response and reduce adverse drug effects from potential overdosing. However, not all of these devices provide accurate dosing.^[5]

Teaspoons and tablespoons are available in almost every household. They are also commonly used for measuring and administering devices of liquid medication. The parents and caregivers tend to use teaspoons instead of other devices like medicine cups, oral droppers and oral syringes. Thus either under dosing or overdosing may occur, resulting in considerable consequences such as a dosing error. Therefore, attempt has been made to evaluate dosing errors in paediatric patients.^[6]

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In India, the parents/caregivers mostly use household kitchen spoon or dosing cup for the measurement of liquid medications. A study concluded that 40% of participants made dosing errors in paediatric liquid formulations.^[7] Therefore, this study has been planned to evaluate dosing errors in paediatric patients and impact of parent/caregiver education in reducing them.

2. MATERIALS AND METHODS:

This is a prospective and experimental, study which was carried out in paediatric ward, Jivraj Mehta Hospital, Ahmedabad. Institutional ethics committee of Jivraj Mehta Smarak Health Foundation approved this study and participants were informed about the study.

2.1. Study Duration: 3 months from date of ethics approval.

2.2. Data collection:

Socio-demographic data and participant characteristics of parents/caregivers who consented for participation viz: gender, age of participant, education level, marital status, language, education and relationship with the patient were collected by the investigator.

2.3. Measures and Study Instrument

To achieve objectives, study was carried out in two phases:

2.4. Pre measurement:

The baseline perception of the participants about the use of measuring devices was assessed with help of a questionnaire. Total 6 questions (short questionnaire about liquid medication administration devices) were asked to respondents. Most of the questions were open ended while two questions were close ended. Respondents were asked on the commonly use medication dosing devices from the available options and request to rate it or answer it. Second question was on the expected reason behind the use. This question explores the reason behind the selection and knowledge of the respondents. Respondents were asked on accuracy and ease of use of measuring device. Responders were requested to rate comparative use of measuring device from the available options.

2.5. Measurement:

The patients were then asked to measure a specified dose of paracetamol suspension. The parents/caregivers were asked by the pharmacist investigators to measure 5 ml of liquid medication with routine instructions (no formal instruction was given on handling and selection of measuring device), and their measurement was verified by the pharmacist-investigator) measuring the same sample with a graduated cylinder. During the medication measuring, wide variety of common house hold and standard devices were provided to participant and freedom was given to choose measuring devise.

2.6. Education and Post education measurement

Post measurement part includes the perception and measurement of the measuring devices after giving the information about the

measuring devices by asking questions to the participants. One of the authors then provided verbal education on proper selection and use of each device and the entire measuring process was repeated. The volume delivered was recorded, and the percent change in volume was also recorded.

2.7. Sample selection criteria

The study is a convenience sample of caregivers for pediatric patients who were admitted in the inpatient department and who were prescribed liquid medication.

2.8. Dosing devices

The household liquid medication measuring devices and other standard measuring devices, which we used are described as below. We titrated the volume capacity of each measure with the help of pipette or cylinder.



Figure 1(A): Calibrated devices Figure 1 (B): Household devices

2.9. Interpretation and Rating of dosing error:

Liquid medication dosing error rates were classified as less than 5%, 6%-10%, 11%-20%, and more than 20% (the measured dose of 5 ml will be the target). We defined volume errors of 10% or less as small and volume errors greater than 10% as large.

2.10. Data analysis & Statistical Application:

- Data analysis was carried out by SPSS (Statistical Package for Social Science) version 17.0.
- Frequency analysis was used for survey, demographic characteristics and the medication measuring device preferences, and the mean and SD determined for the measured dose of the liquid. The chi-square test was performed for the differences in dosing error rates according to the participant characteristics, and *t* test was performed for the differences in measured liquid medication doses according to the participant characteristics.

3. RESULTS

3.1. Demographic details:

The different variables like, gender, age, marital status, language, relationship with the patient, education, children in household and measuring device chosen, are mentioned in table 1.

Table 1: Participants characteristics (N= 128)

Variables	No. of Participants
Age	
20-30 years	58
31-50 years	60
>50 years	10
Gender	
Male	54
Female	74
Marital Status	
Married	122
Unmarried	6
Language	
Gujarati	108
Hindi	20
Relationship with the patient	
Father	40
Mother	56
Grandfather	4
Grandmother	5
Uncle	8
Aunt	6
Caregiver	9
Education	
Uneducated	23
Primary	34
Secondary	35
Higher Secondary	12
Graduate	17
Medical	7
Measuring device chosen	
Calibrated dosing cup	116
Kitchen spoon	2
Oral syringe	10

Table 2 depicts dosing errors of participants before and after education. There is significant ($P<0.001$) reduction after educational intervention.

Table 2: Participants characteristics and Dose error rates in Pre and Post education (N=128)

Variables		Pre measurement				Chi squar	P-value	Post measurement				Chi squar	P-value
		Errors (%)						Errors (%)					
		<5 %	6-10 %	11-20 %	>20 %			<5 %	6-10 %	11-20 %	>20 %		
Gender	Male	28	18	6	2	0.46	0.92	47	7	0	0	2.785	0.2484
	Female	37	24	11	2			67	5	2	0		
Age	20-30 years	26	20	11	1	7.93	0.24	50	7	1	0	1.819	0.7689
	31-50 years	31	20	6	3			54	5	1	0		
	> 50 years	8	2	0	0			10	0	0	0		
Language	Gujarati	55	36	13	4	1.606	0.6579	98	8	2	0	3.443	0.1788
	Hindi	10	6	4	0			16	4	0	0		
Marital status	Married	59	42	17	4	0	0	108	12	2	0	0	0
	Unmarried	0	0	0	0			0	0	0	0		
Relationship	Father	20	12	6	2	14.86	0.6718	33	7	0	0	9.038	0.6996
	Mother	24	21	9	2			49	5	2	0		
	Grandfather	2	2	0	0			4	0	0	0		
	Grandmother	4	1	0	0			5	0	0	0		
	Uncle	4	4	0	0			8	0	0	0		
	Aunt	3	1	2	0			6	0	0	0		
	Caregiver	8	1	0	0			9	0	0	0		
Children	0	0	0	0	26	0.0997	0	0	0	0	15.86	0.1977	
	1	16	13	4			0	28	5	0			0
	2	28	18	9			4	52	5	2			0
	3	12	5	2			0	19	1	0			0
	4	4	1	0			0	5	0	0			0
	5	0	2	0			0	2	0	0			0
	6	1	2	0			0	3	0	0			0
Education	10	0	0	2	0	34.23	0.0032**	1	1	0	0	10.46	0.4008
	Uneducated	8	7	8	0			18	5	0	0		
	Primary	15	15	4	0			31	2	1	0		
	Secondary	21	8	4	2			33	2	0	0		
	Higher Secondary	4	8	0	0			10	2	0	0		
	Graduate	10	4	1	2			15	1	1	0		
Measuring device	Medical	7	0	0	0	56.5	<0.0001**	7	0	0	0	64.82	<0.0001**
	Calibrated dosing cup	56	41	16	3			103	12	0	1		
	Kitchen spoon	0	0	0	2			1	0	1	0		
	Oral syringe	9	1	0	0			10	0	0	0		

** indicates significant p-value.

3.2. Preference score:

Table 3 shows preference score of participants for different dosing devices (Before education)

Table 3: Preference score for measuring devices by participants before education

Measuring devices	Score					
	5	4	3	2	1	0
Regular dosing cup	5	24	36	28	35	0
Calibrated dosing cup	33	64	14	10	7	0
Dosing spoon	2	10	27	40	49	0
Oral syringe	10	11	27	37	37	6
Kitchen spoon	28	38	13	20	28	1
Closure of the bottle	61	33	25	8	1	0

5- Easy to use, 0- Not used

4. DISCUSSION:

This study has provided information about caregivers' accuracy when measuring liquid medication for children. In closely examining the cases with serious dosing error, we found that the maximum dosing deviation was 46 % and n= 1% to n= 49% of participants determined or measured higher than the accepted dose of the medication. In contrast, the less dosing deviation was only 40 % . In our study most caregivers preferred a calibrated dosing cup (n=116) device to measure liquid medication selecting an oral syringe (n=10) and choosing a calibrated spoon (n=2), which is lower than in previous where 51% of caregivers primarily use a household teaspoon. [2]

Dosing and administering medication to children is different from adults. Firstly, pediatric dosages need to be adjusted to age and body weight.^[9] As a result, pediatric populations are considered as more vulnerable to dosage errors.^[8] On the other hand, despite the fact that pediatricians try to calculate, and prescribe, the correct dosages for paediatric medication, the issues of measurement and administration of medication, and especially liquid medication, to children are often underestimated or neglected. Administration of a dose higher than the recommended dosage may lead to serious or even lethal effects while under dosing results in therapeutic failure. Although these are rare cases, they may indicate potential problems in medication dosing associated with the traditional dosing methods. On the other hand, the fact that a parent/caregiver has a wide variety of measures in different sizes, shapes, and consequently with different volume capacities, at his/her disposal when asked to provide liquid medication to their children may result in inaccuracies during measurement and administration of liquid medication with these devices. In present study most of the respondents rated 0 to 5 for the common choice of drug dose measure. Our data are consistent with existing data regarding evaluation of the accuracy of oral liquid measure and error when used by consumers. Madlon-Kay and Mosch F Observed a household teaspoon was the device most frequently used for measuring liquid medication.^[4] Common errors included misinterpreting instructions, confusing teaspoons and tablespoons over a medicine cup, and misreading a dosage chart when weight and age were discordant. McMahon and colleague reported that when caregiver received patient specific dosing instruction for use of an oral syringe in combination with demonstration measuring accuracy was significantly increased. When wide and versatile measures are present with no specificity make caregiver confused. Moreover, parents and caregivers may be confused by the disparity observed in the information contained in packinserts; few of them advise against the use of teaspoon/tablespoon, whereas others suggest administration with these utensils. This can be embarrassing and probably bigger when liquid medication is administered to small children who may not stand still or cry.^[8] Caregivers must be educated to ensure the best possible outcome for the error reduction and children. It is possible that some treatment failures are attributable to incorrect dosing of medication rather than to incorrect choice of medication. Being as a first point of contact to patient on medication use, pharmacist must educate medicine users and such communication is essential. Caregivers may want to do something in medication but feel something over/underwhelming at ward site. Pharmacist needs to empower them with proper information. At present we don't want to comment our result directly with published data those varies from setting to settings and population to population. We did not detect and correlate level of education and its association with error. To be make sure that error is prevailed and existence, we did not stratified respondents on level of education. In another study

higher education was not likely contributing to the lower dosing error in specific group. Education intervention helps to reduced measuring error and the same is consistent in our study too.

5. CONCLUSION:

We concluded that participants were more likely to measure an acceptable dose with calibrated dosing cup and cap of the bottle as compared to other measuring devices. Proper Education or instructions by the pharmacist reduce liquid dose measurement errors.

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