## Parent Medication Administration Errors: Role of Dosing Instruments and Health Literacy



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# Medication Administration Errors in Children

- Outpatient medication administration errors are frequent
  - <u>>50% caregivers give an incorrect dose of liquid</u> medicine (Frush 2004; Li 2000; Simon 1997; McMahon 1997)
- Medication administration errors account for 70% of preventable pediatric outpatient ADEs (Zandieh 2008)



# **Dosing Instruments and Medication Errors**

- Parent choice of measuring device important for dosing accuracy
- Non-standardized kitchen spoons inaccurate
- Standardized dosing instruments
  - Many types, variability
  - Oral syringes used by health professionals for maximal accuracy



 Few studies have examined parent ability to dose with the range of available instruments

# Health Literacy & Medication Errors

- In adults, low health literacy has been linked to
  - poor comprehension of Rx labels (Davis 2006)
  - non-adherence (Osborn 2007; Gazmararian 2006; Kalichman 1999)
- Few studies have assessed the role of parent health literacy and medication errors in children
  - Parent ability to use dosing instruments accurately



# **Study Objective**



- To assess rates of parent dosing error by instrument type
- To examine the role of parent health literacy in the accurate use of dosing instruments

# **Study Design**

- Experimental study
- Urban public hospital pediatric outpatient clinic
- Eligibility criteria
  - Parent / legal guardian
    - Responsible for administering medication to child
    - English / Spanish language

## **Predictor Variables**

- Two predictor variables
  - Dosing Instrument Type
  - Caregiver Health Literacy (HL)

## **Predictor Variable:** *Dosing Instrument Type*

"Let's pretend your child is 3 years old, and has a fever. You find out that the right dose for your child is 1 teaspoon or 5 mL. Please measure this amount using each dosing instrument."





ORAL SYRINGE + PRESS-IN BOTTLE ADAPTER





ORAL SYRINGE

## **Predictor Variable:** *Dosing Instrument Type*

Parents asked to dose "1 teaspoon or 5 mL" using 4 types of instruments

 Order of dosing with each instrument randomized





ORAL SYRINGE

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oral syringe + press-in Bottle Adapter





ORAL SYRINGE

# **Predictor Variable:** Health Literacy

- Caregiver Health Literacy (HL)
  - Newest Vital Sign (NVS)
    - Food label
      - 6 accompanying questions
    - Validated in English and Spanish
    - Categorization
      - Adequate Literacy
      - Possible Limited Literacy
      - Limited Literacy

Nutri Servir Servir	tion I ng Siz ngs pe	F <b>acts</b> e er container		½ cup 4		
Amou Calori	int per ies	serving 250	Fat Cal	120		
				%DV		
Total	Fat 1	l3g		20%		
Sa	t Fat	9g		40%		
Chole	esterc	l 28mg		12%		
Sodiu	im 55	ōmg		2%		
Total	Carb	ohydrate 30g		12%		
Die	tary F	iber 2g				
Sug	gars 2	23g				
Prote	in 4g			8%		
*Percer 2,00 be h calo Ing	SC	ore Shee Que	t for th	ne Ne and	ewest \ Answe	/ital Sig
Mile	READ	TO SUBJECT: This inf	ormation is on	the back		ANSWER
IVIIID.			STUDIES OF LOUIS			

- 1. If you eat the entire container, how many calories will you eat? Answer: 1,000 is the only correct answer
- 2. If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have? Answer: Any of the following is correct: 1 cup (or any amount up to 1 cup), Half the container Note: If patient answers "two servings," ask "How much ice cream would that be if you were to measure it into a bowl.

ANSWER CORRECT yes no

3. Your doctor advises you to reduce the amount of saturated fat in your diet.

# Outcome Variable: Observed Dosing Accuracy

- Standard bottle of children's acetaminophen suspension
- % Deviation From Dose
  - Parent Measured Dose Wt compared to Reference Measured Dose Wt
    - Reference Measured Dose Wt = Average Measured Dose Weight of 5mL for 5 pediatricians using the oral syringe

Measured Dose Weight =



Wt of Instrument Containing Measured Dose



minus

Pre-assessment Empty Instrument Weight

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# Outcome Variable: Observed Dosing Accuracy (cont'd)

- Parent dose considered accurate if within 20% of reference dose (Yin 2008; Kozer 2002; Simon 1997)
  - Small error
    - Deviation of >20-40% from dose
  - Large error
    - Deviation of >40% from dose
- Conservative, compared to USP

   USP: Standard volumetric error should be within 10% for dosing instruments

# **Potential Confounders**

#### Caregiver

- Age
- Relationship to child
- Language
- Ethnicity
- Country of birth
- SES

## Child

- Presence of child
   <8y in household</li>
- # of children
- Presence of child in household with chronic illness

# **Statistical Analysis**

- Unadjusted analyses
  - Chi square
  - Fisher's exact test
- Multivariate logistic regression analyses
   Generalized estimating equations

## **Results: Descriptive Data** (n=302)

#### **CHILD-RELATED**

Presence of child <age 8 in home</th>86%# of children (mean (SD))2.1 (1.2)Presence of child with chronic disease32%

#### **CAREGIVER-RELATED**

Caregiver Age (yrs, mean (SD))31.1 (8.6)Relationship to Child: Mother95%Caregiver Ethnicity Latino80%Caregiver non-US born76%Hollingshead SES Level 4 or 581%

## **Results:** Descriptive Data (cont'd)



# Results: Dosing Errors by Instrument Type

















### **Results: Dosing Accuracy -** Dropper & Dosing Spoon



#### **Results:** Dosing Accuracy - Syringes





- Multivariate Analysis -

Dosing Error Defined as >20% Deviation from Dose

	AOR <sup>†</sup>	95% CI	р
Dosing Cup #1	26.3 🖊	16.5-41.9	<0.0001
Dosing Cup #2	10.9 🖊	7.1-16.6	<0.0001
Dosing Spoon	1.7	1.1-2.7	0.02
Dropper	0.6	0.4-1.0	0.1
Syringe+Adapter	1.1	0.7-1.6	0.7
Oral Syringe	1.0		

- Multivariate Analysis -

Dosing Error Defined as >20% Deviation from Dose

	AOR <sup>†</sup>	95% CI	р
Dosing Cup #1	26.3	16.5-41.9	<0.0001
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Syringe+Adapter	1.1	0.7-1.6	0.7 🗡
Oral Syringe	1.0		4

- Multivariate Analysis -

Large Dosing Error of <a>>40%</a> Deviation from Dose

	AOR <sup>†</sup>	95% CI	р
Dosing Cup #1	7.3 🖊	4.0-13.2	<0.0001
Dosing Cup #2	6.3 🖊	3.5-11.2	<0.0001
Dosing Spoon	0.3	0.1-0.9	0.02
Dropper	0.9	0.5-1.5	0.6
Syringe+Adapter	0.8	0.5-1.5	0.6
Oral Syringe	1.0		

- Multivariate Analysis -

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## **Results: Accuracy with Standardized Instruments**

### Exploratory Analyses: Dosing Cups & Eye Level Verification

	No	Small	Large	
	Error	Error	Error	
Eye Level	57%	30%	14%	
Not Eye Level	33%	38%	30%	

- Eye level verification (n=59)
  - Dosing Cup #1: 25%
  - Dosing Cup #2: 38%
  - p=0.15

# - Role of Health Literacy -

<ul> <li>Any</li> </ul>		AOR <sup>†</sup>	95% CI	р
Dosing	Limited HL	1.7	1.1-2.7	0.03
Error	Possible Limited HL	1.6	0.98-2.5	0.06
	Adequate HL	1.0		
<ul> <li>Large</li> </ul>		<b>AOR</b> <sup>†</sup>	95% CI	р
<ul> <li>Large</li> <li>Dosing</li> </ul>	Limited HL	<b>AOR</b> <sup>†</sup> 2.3	<b>95% Cl</b> 1.2-4.4	<b>p</b> 0.02
<ul> <li>Large</li> <li>Dosing</li> <li>Errors</li> </ul>	Limited HL Possible Limited HL	AOR <sup>†</sup> 2.3           1.8	<b>95% Cl</b> 1.2-4.4 0.9-3.6	<b>p</b> 0.02 0.08

# - Role of Health Literacy -

• Any		AOR <sup>†</sup>	95% CI	р
Dosing	Limited HL	1.7	1.1-2.7	0.03
Error	Possible Limited HL	1.6	0.98-2.5	0.06
	Adequate HL	1.0		
<ul> <li>Large</li> </ul>		<b>AOR</b> <sup>†</sup>	95% CI	р
<ul> <li>Large</li> <li>Dosing</li> </ul>	Limited HL	<b>AOR</b> <sup>†</sup> 2.3	<b>95% Cl</b> 1.2-4.4	<b>p</b> 0.02 -
<ul> <li>Large Dosing Errors</li> </ul>	Limited HL Possible Limited HL	AOR <sup>†</sup> 2.3 1.8	<b>95% Cl</b> 1.2-4.4 0.9-3.6	<b>p</b> 0.02 <b>4</b> 0.08 <b>4</b>



## Results: Dosing Errors and Parent Health Literacy by Instrument Type

■ Large Error (>40%)

Small Error (>20-40%)

■ No Error (within 20%)







## *Results:* Dosing Errors and Parent Health Literacy by Instrument Type

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# Role of Health Literacy in Dosing Errors By Instrument Type

## Statistically significant

- Dosing cup #1
- Dosing cup #2
- Dosing spoon
- Trend
  - Dropper
  - Oral syringe + adapter
- No significance
   Oral syringe

# Summary

- Parent dosing accuracy varies by instrument
  - Fewer errors with droppers dosing spoons, and syringes
  - Dosing cups associated with the most errors; primarily overdosing



- Parent health literacy also found to be associated with dosing accuracy
  - Greatest association seen for the two dosing cups and the dosing spoon

# Limitations

- Dosing assessment performed under experimental conditions, may not reflect caregiver's true ability to dose at home
- Representative sample of instruments chosen; all dosing instrument variations could not be tested
- The degree to which the dosing errors found would be associated with adverse clinical outcomes unclear
  - Multiple cutpoints utilized

## Implications

- Strategies to decrease medication dosing errors in children should address
  - Accurate dosing instrument use
  - Parent health literacy skills
- Additional study needed to better understand the factors which relate instrument type to error



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