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## Parental Knowledge and Practice on Liquid Medication for the Use of Children at Home

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### ABSTRACT

**Introduction:** Little is known about medication errors among paediatrics that occur at home. Previous studies have shown that the majority of medication errors among children occur during medication administration.

**Objective:** This study aimed to identify parental knowledge and practice on liquid medication for children; to determine whether intervention during medication dispensing is needed to reduce medication errors among children that occur at home.

**Methods:** We conducted a cross-sectional study in the Paediatric Medical Ward of Sarawak General Hospital from August until September 2018. Data were collected using a self-administered questionnaire available in Malay and English and analysed using SPSS software. Questionnaire items were self-developed and validated in a cohort of 20 patients locally. The items were then tested for reliability using Cronbach's alpha.

**Results:** A total of 251 parents included. Antipyretics (87.6%) along with cough & cold medicines (61.8%) were the most common type of medication given by parents for acute illnesses. Most parents obtained their children's medication from government health facilities (88.0%) and received information on liquid medication from healthcare professionals, namely doctors (82.9%) and pharmacists (60.2%). In terms of medication administration, only 49.8% of

parents measured the correct volume of medication using oral syringes. 24.3% of parents used tablespoons whilst 27.5% used teaspoons at least once to administer liquid medication to their children. More than 20% of parents were unaware of the stability of reconstituted antibiotics while 56.2% had a wrong understanding on the storage of the liquid medication. Parents with higher education level had better knowledge of liquid medication in terms of understanding vehicle used to reconstitute oral antibiotics, dosing, measurement as well as storage ( $p < 0.05$ ).

**Conclusion:** There are some areas in which parental knowledge of liquid medication are lacking. It is also worth considering having standardisation on dosing tools for liquid medication to avoid dosing errors.

**Keywords:** Liquid medication, paediatric, parental knowledge, practice

## INTRODUCTION

Children and adults may need the same medication for the same illness, but the use of medication in children is often more challenging as children are not small adults. The vulnerability of children, especially infants simply emphasise the special need in paediatric medicine (1), consequently a higher risk of medication errors in children than adults (2). A small dosing error in children carries a significant harm compared to the adult population. Reports suggest that more than 40% of caregivers make errors when dosing liquid medication in children (3). Liquid formulation like syrup, solution and suspension are commonly prescribed and is the preferred oral formulation for children as pleasant-tasting excipients often added and hence, more palatable (1,4).

Medication errors may involve both healthcare professionals and patients or caregivers. The errors can be classified according to whether they are knowledge-based errors or behaviour/attitude-based errors (3). Medication errors in children may occur due to several reasons. One of them is the weight-based calculation of the drug doses (5). The different concentrations of liquid medication can also lead to dosing errors (5). Furthermore, some paediatric elixirs reconstituted from powder (5). Therefore, the administration of medication in children can be complicated and challenging.

While most medication errors reported occur in the healthcare facilities, little is known about medication errors that occur at home, especially among paediatrics. Paediatric population require caregivers to administer medications. Previous studies reported in a systematic review have shown that the majority of medication errors among children occur during medication administration (2). However, many caregivers are unaware of the errors. In the United States, medication errors involving children is one of the common public health problems. Between 2002-2012, almost 30% of out-of-hospital medication errors reported to the United States Poison Control Centers involved children aged less than six years (6). On average, one child experienced an out-of-hospital medication error every eight minutes during that 10-year period<sup>6</sup>. Among the most common medication causing medication errors in children included analgesics followed by cough and cold preparations and more than 80% of these errors involved liquid-based medication (6). Medication errors that happened had various medical consequences; a

number of these errors were severe and fatal. Apart from the risk of overdosing the medication, medication errors in children may also cause underdosing of medication, hence treatment failure (6,7). Medication errors involving paediatrics are alarming and cause significant public health concern due to the appreciable risk of morbidity and mortality, and hence, increase the healthcare expenditure.

Due to the growing concern on the safe use of medication in children, many have addressed problems like unstandardised dosing tools in prescribing liquid medication for children, whereby devices like dosing cup, tablespoon and teaspoon are reported to cause more dosing errors in comparison with calibrated oral syringe (4,8,9). However, there are other issues involving liquid-based medication which are associated with home medication errors among children. There have been reports on overdosing of paracetamol, inaccuracy of dosing liquid medication which may cause suboptimal treatment, and difficulty understanding instructions on the bottle label (5,9). There are also issues on the stability of liquid-based medication, especially those medicines that need to reconstitute with water before ingestion (1,5). Therefore, it is essential to understand the knowledge and practice of parents on the administration of liquid-based medication for children that might help to enhance the communication between pharmacists and parents during medication dispensing. Pharmacist-based education reported being one of the essential points to reduce medication errors in paediatrics (2,4).

To date, paediatric home medication errors have not been studied thoroughly at our local setting to provide information that can be intervened for parental education. Findings from a study by You and peers in 2015 showed that more than 95% of parents think that there is a need for an education programme on medication administration among children (8). Therefore, this study aims to identify the parental knowledge and practice on liquid medication for children so that this information can be utilised during medication dispensing or counselling in order to reduce home medication errors among children.

## **METHODS**

We conducted a cross-sectional study using a self-administered questionnaire, in a paediatric medical ward in Sarawak General Hospital from 20<sup>th</sup> August 2018 until 21<sup>st</sup> September 2018. Sarawak General Hospital is a tertiary government hospital located in Kuching, the capital city of the state of Sarawak, Malaysia.

This study recruited parents who (a) were 18 years old and above; (b) had given the child at least one liquid medication for acute illness at home. We excluded parents who (a) were illiterate; (b) were unable to understand English or Malay language, as the questionnaire designed in these two languages; and (c) had children with chronic illnesses such as chronic lung disease, chronic heart disease, epilepsy, psychiatric disorder and others.

Written informed consent must be obtained from the respondents before the authors proceeded with the survey. The self-administered questionnaire was made available in both Malay and English languages. The questionnaire was self-designed after reviewing relevant literature on liquid medication in children. It is divided into four parts; demographic characteristics, usage of liquid medication, knowledge of liquid medication and practice on liquid medication usage.

**Part 1** was to obtain the demographic characteristics of the respondents, including their age, gender, race, education level, employment status and whether their job is related to healthcare, monthly income, number and age of children.

**Part 2** of the questionnaire consisted of the usage of liquid medications among children at home.

**Part 3** was to evaluate the knowledge of parents on the administration of liquid medication, and also the stability and storage of liquid medication (ten statements). Respondents were required to choose among the three options provided either 'Yes', 'No' or 'Not Sure'.

As for **Part 4**, which was the final part of the questionnaire, a total of ten statements which addressed the practice on administration and storage of liquid medication were included. 3 point

scale ranging from 'Always', 'Sometimes' and 'Never' were used to assess the response of respondents regarding the practice.

All the 31 questionnaire items were validated in a cohort of 20 patients locally. The items then tested for reliability using Cronbach's alpha, in which the coefficient alpha value was  $>0.7$ .

Determination of sample size calculated using SurveyMonkey software. At least 250 subjects were needed to get study power of at least 80%. Statistical Package for Social Sciences (SPSS) version 20.0 used to analyse the data. The relationship between demographic characteristics towards parental knowledge or practice on liquid medication tested using Chi-Square tests. The degree of relationship among the variables was analysed using Spearman rank correlation. The level of significance set at 0.05.

## **RESULTS**

A total of 251 parents enrolled in this study. None of the parents refused to take part in this questionnaire. The demographic characteristics of the parents shown in Table 1. 92.0% of the respondents were female, and 58.2% were Malays. The maximum age distribution of the respondents was between 31-35 years old, which accounted for 32.3%. The parents had average education, majority completed at least secondary school. Only 27.5% of the respondents had at least completed tertiary education. The ratio of the employment status of the respondents was almost similar. About 6% of the working parents were the medical staff. The respondents had two children on average, and the majority of the children aged 1-6.

All the parents experienced giving liquid medication to their children at home. Antipyretics (87.6%) along with cough & cold medicines (61.8%) were the most common type of medication given by parents. Regarding the source of medication, parents usually brought their children to government health facilities (88.0%), including public hospitals and health clinics, in which their children discharged with medication after consultation with doctors. 31.9% reported that they purchased liquid medication from retail pharmacies, with or without a prescription.

**Table 1.** Demographic characteristics of respondents

<b>Demographic characteristic</b>	<b>Number of respondents, n</b>	<b>Percentage of respondents, %</b>
<b>Mean age (years)</b>	31.2 (SD=6.4)	
<b>Age range (years)</b>	18-54	
<b>Gender</b>		
Male	20	8.0
Female	231	92.0
<b>Race</b>		
Malay	146	58.2
Chinese	14	5.6
Iban	30	12.0
Bidayuh	48	19.1
Others	13	5.2
<b>Education</b>		
Primary school	16	6.4
Secondary school	166	66.1
College/University	69	27.5
<b>Employment</b>		
Yes	123	49.0
No	128	51.0
<b>Monthly income</b>		
≤RM1000	142	56.6
RM1001-RM2000	56	22.3
RM2001-RM3000	27	10.8
RM3001-RM4000	12	4.8
>RM4000	14	5.6
<b>Number of children, mean</b>	2.29 (SD=1.142)	
<b>Age of children</b>		
<1 year	99	39.4
1-6 years	189	75.3
7-12 years	121	48.2

\*SD = Standard deviation

Majority of parents received information on liquid medication for children from healthcare professionals, namely doctors (82.9%) and pharmacists (60.2%). Only about half of the respondents responded that one of the sources of information regarding liquid medication was medication label on the bottle.

**Table 2.** Parental knowledge of liquid medication for children

<b>Parameter</b>	<b>Number of respondents, n</b>	<b>Percentage of respondents, %</b>
<b>Milk or fruit juice can be used to reconstitute antibiotic dry powder</b>		
Yes	38	15.1
No	112	44.6
Unsure	101	40.2
<b>Liquid medication is dosed based on body weight</b>		
Yes	211	84.1
No	17	6.8
Unsure	23	9.2
<b>Liquid medication is dosed based on age</b>		
Yes	204	81.3
No	32	12.7
Unsure	15	6.0
<b>My kid needs the same volume of liquid medication of different strength</b>		
Yes	73	29.1
No	108	43.0
Unsure	70	27.9
<b>Measure the correct volume of liquid medication using an oral syringe</b>		
Yes	116	46.2
No	125	49.8
Unsure	10	4.0
<b>Reconstituted dry powder antibiotic can be kept until the expiry date on the bottle</b>		
Yes	55	21.9
No	162	64.5
Unsure	34	13.5
<b>All liquid medication must be kept in the fridge</b>		
Yes	141	56.2
No	59	23.5
Unsure	51	20.3

From the results presented in Table 2, regarding the knowledge about liquid medication, the highest correct response was that the respondent understood that liquid medication in children is dosed based on body weight (84.1%). However, there was a significantly high proportion of respondents (81.3%) who believed that liquid medication is also dosed based on the child's age. In terms of administration of medication, only 49.8% of the respondents answered the correct volume of liquid medication measured using an oral syringe. Besides, about 30% of the respondents incorrectly thought that children need the same volume despite the different concentration of liquid medication. 15.1% of the respondents reconstituted antibiotic powder with milk and fruit juice. There was also knowledge deficiency on the storage and stability of liquid medication. In particular, more than 20% of the respondents were not aware that reconstituted dry powder antibiotic could not be kept beyond its stability period and 56.2% had a wrong understanding on the storage of the liquid medication. They thought that it is best to keep all liquid medication in the fridge.

Table 3 shows that respondents reported using a tablespoon (24.3%) and a teaspoon (27.5%) at least once to administer liquid medication to their children. 4.4% stated that they never use an oral syringe to administer the liquid medication. Among the 190 respondents who had more than one child, 4.4% had ever given the same dose of liquid medication to their children while 29.1% reported that they shared liquid medication among their children. About 11.6% answered that they had ever kept the reconstituted antibiotics for future use. Majority of the respondents (61.0%) understood the indication of medication for their children, and 93.6% always checked the expiry date of medication before administration.

**Table 3.** Parental practice on liquid medication among their children

<b>Parameter</b>	<b>Number of respondents, n</b>	<b>Percentage of respondents, %</b>
<b>I use an oral syringe to measure liquid medication</b>		
Always	202	80.5
Sometimes	38	15.1
Never	11	4.4
<b>I use a tablespoon to measure liquid medication</b>		
Always	3	1.2
Sometimes	58	23.1
Never	190	75.7
<b>I use a teaspoon to measure liquid medication</b>	11	4.4
Always	58	23.1
Sometimes	182	72.5
Never		
<b>I give the same dose of liquid medication to all my children*</b>		
Always	3	1.2
Sometimes	8	4.4
Never	179	75.7
<b>I know the indication of liquid medication</b>		
Always	153	61.0
Sometimes	83	33.1
Never	15	6.0
<b>I keep the leftover reconstituted antibiotic</b>	10	4.0
Always	19	7.6
Sometimes	222	88.4
Never		
<b>I check the expiry date of liquid medication before giving it to my child</b>		
Always	235	93.6
Sometimes	14	5.6
Never	2	0.8

\*Only for parents who have more than one child

From this study, we found out that parents' education background significantly affects parental knowledge of liquid medication among children. Respondents with higher education level had better knowledge of liquid medication in terms of understanding vehicle used to reconstitute oral antibiotics ( $p=0.002$ ), dosing of liquid medication in children ( $p<0.05$ ), measurement ( $p=0.000$ ) as well as storage of liquid medication ( $p=0.01$ ). However, there is no significant difference between parents' education level and knowledge of the stability of reconstituted antibiotics and other liquid medication ( $p>0.05$ ). Those parents with better education background had significantly better practice in terms of choosing dosing tools for measurement of liquid medication in children ( $p<0.05$ ). However, in terms of parental practice in sharing liquid medication among children, storage of reconstituted antibiotics and other liquid medication, and checking of expiry of liquid medication, there is no significant difference between these practices and parents' education level ( $p>0.05$ ).

## **DISCUSSION**

The top categories of medications involved in medication errors among children in the United States are analgesics (25.2%), cough and cold preparations (24.6%), antihistamines (15.0%) and antibiotics (11.8%) (6). Antipyretics (94.4%) was the most common category of medication given by caretaker in Korea to their children at home, other than decongestants (89.4%) and antibiotics (77.7%) (8). Our findings are similar; antipyretics (87.6%) being the highest category of liquid medication administered to children, followed by cough & cold preparations and antibiotics, 61.8% and 55.4% respectively. Paracetamol is reported to be the most commonly used antipyretic among children (10).

Most of the parents in our study obtained liquid medication for their children from government health facilities (88.0%), compared to private healthcare and retail pharmacies, which may be due to the free healthcare policy by the Malaysian government.

Yin et al. (2007) reported that 23.3% of the caregivers used a nonstandard kitchen teaspoon or tablespoon to dose liquid medication at home (11). The primary dosing instruments used for administering liquid medications in children in another study were dosing cups (43.6%), dosing bottles (32.9%), oral syringes (11.7%), cylindrical spoons (8.4%) and household spoons (3.4%)

(8). Our study revealed that 80.5% of the caregivers always use oral syringes to administer liquid medication to their children. However, there are more than one-quarter of parents who still use a household teaspoon and a tablespoon to measure medication for their children. The findings from a recent study by Yin et al. (2016) showed that parents who received teaspoon-only labels and teaspoon dosing tools made significantly more errors than those receiving ml-only labels and dosing tools (12). Dosing cups are generally associated with more errors compared with oral syringes, particularly for smaller doses (12). Therefore, the study findings recommend the use of oral syringes over other dosing tools because of the accuracy (12). The high number of errors from dosing cups are mainly due to the wrong eye position when reading the volume of liquid medication in the dosing cup (12). Some pharmaceutical companies provide dosing tools with liquid medication. The variability of the dosing tools may contribute to dosing errors at home. To date, there is no local, national guideline on the type of dosing tool that should be provided to caregivers.

In our study, only about half of the parents measured the correct volume of medication using oral syringes. Even with oral syringes, a significant number of parents made dosing errors (12). Oral syringes have different sizes and increment markings which may lead to confusion among parents. More intensive education and counselling, including strategies like demonstration and teach-back or show back, are crucial for better understanding among caregivers, instead of just verbally explaining the dose of medication.

About 30% of parents in our study are not aware of the different concentration of the same medication, for example, the concentration of paracetamol suspension liquid in public healthcare facilities is 120mg/5ml whereas the concentration of the same medication in most private healthcare facilities or retail pharmacies is 250mg/5ml. This percentage is almost similar to the percentage from a study done in an urban paediatric emergency department in New Orleans; in which 27% of parents did not know that there is a difference in concentration between children's paracetamol liquid (160mg/5ml) and infant's paracetamol drop (500mg/5ml), which may cause parents to inadvertently give three times higher dose of paracetamol to infants which is hepatotoxic (13).

Yin et al. (2007) found the association between low health literacy and the knowledge deficiency on the weight-based dosing among caregivers (11). In our population, more than 80% of parents believed that liquid medication in children is dosed based on the child's weight. This finding shows improvement from the previous study, which reported that about 70% of the caregivers were not aware that weight rather than age is the determinant of the dosage of liquid medication among children (11). Nevertheless, the parental understanding on the dosing of liquid medication in our population still lacks as a significantly high proportion of parents thought that liquid medication is also dosed based on the child's age.

Most antibiotics for bacterial infection in children usually dispensed as a dry powder while the dry powder antibiotics have to reconstitute with a suitable vehicle like distilled or boiled then cooled tap water before administration. Al Ramahi et al. reported that 77.3% of caregivers use an appropriate vehicle to reconstitute dry powder antibiotics (14). The others used tap water directly and mineral water (14). These vehicles are inappropriate due to the high amount of multivalent cations that may chelate the antibiotic molecules, contaminants and microorganisms (14). Our findings showed that 55.3% of caregivers incorrectly thought that milk and fruit juices could reconstitute antibiotics dry powder. Therefore, more intensive and detailed counselling is essential, given the high percentage of incorrect practice among parents. An inappropriate vehicle used may affect the stability of antibiotics hence alter its activity. As a consequence, treatment failure may occur leading to antibiotic resistance.

Storage of liquid medication differs slightly among manufacturers. Some medications need refrigeration while there are others which should not be refrigerated. Our study findings showed that more than 50% reported that all liquid medication must be refrigerated. Different storage conditions of liquid medication may affect the drug properties and therapeutic effects (14). Therefore, it is mandatory to follow manufacturers' instructions not only in terms of storage of liquid medication but also the stability of reconstituted antibiotics. Previous studies found that 6.5% and 15% of parents gave their children leftover antibiotic suspensions that they had saved from the previous course of antibiotics (14,15).

Our study found that about 35.4% of caregivers believed that the leftover of the reconstituted antibiotics could be kept for future use, and 11.6% had kept the leftover reconstituted antibiotics

at least once. Also, 29.1% of parents shared liquid medication among their children at home. The percentage is slightly higher than another study in Malaysia which found that 24% of parents shared the antibiotics initially prescribed for one child (15). Sharing antibiotics among children can have detrimental effects both at the individual and community levels especially with the development of antibiotic resistance. In a research done on parental misinterpretations of over-the-counter paediatric cough and cold medication labels, among the factors reported influencing the parental perception of product age indication were the word 'infant' on the package label and infant-related graphics, for example, depictions of infants and teddy bears which do not represent the correct age group (16).

In our study, parents with better education background had significantly better practice in terms of choosing dosing tools for measurement of liquid medication in children ( $p < 0.05$ ). A systematic review of eight studies found a positive relationship between parental literacy and knowledge about health outcomes and behaviours (17). Another study by Yin et al. (2007) showed that parents with lower literacy make more dosing errors (11). Therefore, healthcare professionals should not assume that parents understand the instruction on liquid medication and counselling should be catered to individual knowledge and understanding.

This study has several limitations that should be considered. First, as this is a cross-sectional study, the findings from this survey are dependent on self-reporting. Thus, the accuracy of the reporting is questionable as some of the respondents may not recall their practice at home. The second limitation is that some parents may not answer correctly and truthfully due to the inability to focus on answering the questionnaire when their children admitted to the ward.

## **CONCLUSION**

In conclusion, this study has pointed out some areas in which parental knowledge of liquid medication are lacking, hence leading to inappropriate practices among caregivers. It is also worth to consider having standardisation or a local guideline on the choice of dosing tools for liquid medication, especially among manufacturers to avoid dosing errors from non-standardisation of dosing devices. A more thorough educational effort and intervention can be made by focussing on weak areas in parent's knowledge and practices.

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## CONFLICT OF INTEREST

The authors declare that they have no competing interests to disclose.

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