ORIGINAL ARTICLE

Exploration of Caregivers' Knowledge and Practice on Handling Oral Liquid Medications in Children: A Focus Group Discussion

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ABSTRACT

Introduction: Children depend on their caregivers for accurate medication administration. Caregiver's knowledge is crucial for the appropriate administration of liquid medications to their children. **Objective:** To explore caregiver's knowledge and practices in dosing, storage, disposal, and reconstitution of oral liquid medications among children. **Methods:** A qualitative study via Focus Group Discussion was performed. The study included 10 groups of 42 caregivers with children under 6 years old. Thematic analysis was performed using NVivo 12. **Results:** Five key themes were identified and explored. The themes are: 1) Dosing of liquid medications, 2) Storage of liquid medications, 3) Disposal of unused or expired liquid medications, 4) Reconstitution of dry powders, and 5) Expectations of caregivers. Caregivers have good dosing practices for oral liquid medications, but some still lack knowledge of dosing intervals and are mixing medications with beverages, which is an incorrect practice. Caregivers have suboptimal knowledge of missed doses, which requires further exploration, and they have a fair knowledge of storage practices. The majority empty the liquid medications into the sink before dumping them. Despite knowing that dumping the medication directly is unsafe, caregivers are unsure of how to dispose of it safely. Experienced caregivers have been found to have adequate reconstitution practices. Most caregivers are dissatisfied with the healthcare provider's lack of communication and expect more information on medication dosing, side effects, and disposal. **Conclusion:** This study shows that there is room for improvement by both caregivers and healthcare providers in ensuring the proper handling of liquid medications among children.

Keywords: Child; Caregivers; Focus Groups; Oral Drug Administration

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INTRODUCTION

The liquid formulation of medications is the predominantly administered dosage form for children of young age because a liquid form is the simplest dosage form of drug to be provided to young children.[1] Caregivers frequently play a crucial role in administering or monitoring medications before children can be trusted to manage their medication consumption.[2] A research study conducted in 2015 showed that more than 80% of the medication errors that occurred in young children were related to out-of-hospital settings and mainly involved liquid formulations.[3] Inadequate knowledge of liquid medications in children among caregivers has been the major reason leading to countless adverse drug events such as dosing errors (overdosing or underdosing), inappropriate storage, and disposal of medications.[1]

The occurrence of dosing errors in children is three times more common than in adults.[4] This is because paediatric doses must be determined on an individual basis depending on a variety of criteria, such as the patient's age and weight. Thus, these types of errors lead to suffering in children, especially in those who must receive long-term treatment. Consequently, this might lead to disability, hospitalization, an escalation of healthcare costs, or even death.[5] According to the Centers for Disease Control and Prevention (CDC), Pediatrics and Population Health at the New York University, School of Medicine stated that dosing errors are a common reason for children to be brought to the Emergency Department. Caregivers tend to be confused with the units used for the measurement of liquid medications, such as the dose in mL (millilitres), ounces, teaspoons, and tablespoons. Consequently, this leads to large errors in the dosing of medication.[6] Despite the fact that oral liquid formulation is the most suitable dosage form to be administered to children, if the volume of liquid exceeds even a few millilitres, it can cause vomiting or spitting or even serious cases of overdose.[7] Moreover, medication errors can occur as a result of improper administration of oral liquid drugs to children, including using inappropriate dosing tools, administering at incorrect intervals or doses, or mixing medication with a specific food or beverage (milk or juice).[8]

Besides medication errors, caregivers' adherence to administration is a critical component in ensuring that children obtain good efficacy from pharmacological treatment. Unfortunately, the variations in the caregiver's adherence to the administration of medication (keeping a record of medication administration, precise measurement of dose, communicating with partners, method of preparing medication, technique of administration to children, caregivers' adherence to dose and length of treatment prescribed) ranged from 43% to 100% across countries.[1] It is well-known that caregivers' non-adherence to medication administration has resulted in the global healthcare system bearing a financial burden due to suboptimal treatment outcomes.[1] A study carried out in Malaysia found that the adherence of caregivers is another difficult problem in the delivery of medications. In two trials that independently assessed the effects of solid and liquid drug formulations, adding liquid medication to treatment regimens significantly reduced adherence.[3]

The Ministry of Health in Malaysia emphasised that there are only a few studies on medication handling among children outside hospital settings.[1] To date, there have been no studies carried out to explore the knowledge and practice of caregivers in the handling of oral liquid medications in children. In order to evaluate the knowledge and practice of caregivers in handling oral liquid medications in children, a phenomenological study is required.

Children's acceptance of medication may depend on several factors, including the ways parents administer it at home as well as how the medication tastes.[9] In the literature, several methods have been mentioned, such as mixing medications with food or beverages.[9] Since the use of liquid medications in community settings can be done in many ways, a qualitative study was conducted. Filling out a survey form with options will mislead participants into selecting only the available options. Focus group discussion (FGD) therefore enables participants to freely mention their practice methods and allows the researcher to gain additional insight into the knowledge participants have and lack. Thus, this study will help educate caregivers in the future, especially new parents who lack knowledge and experience in handling liquid medications. In addition, the feedback on the information that caregivers expect from healthcare providers will assist in formulating the necessary tools to disseminate best practices on handling liquid medications to the public.

MATERIALS AND METHODS

Study Design

A qualitative research design involving semi-structured interviews was conducted among caregivers over 20 years old, taking care of at least one child below 6 years old. This was done to determine caregiver's knowledge and practice of liquid medication usage.

Population and eligibility

A total of 10 FGD were conducted, and a total of 42 participants were selected. The number of participants in each group was in the range of 3-5. However, this study excluded caregivers who do not understand English or Bahasa Malaysia and caregivers who are healthcare professionals. The FGD was conducted until saturation was achieved. The recruitment of the participants was done by utilising the snowball sampling technique because the inclusion criteria had to be Malaysian caregivers who are currently taking care of children below 6 years old; hence, using this technique allowed us to get the right subjects. Most of the caregivers in this study were from the northern region of Peninsular Malaysia. The FGD flyers were circulated to family, friends, and neighbours through WhatsApp, email, and in person at kindergartens. Then, all the participants were chosen based on the inclusion criteria, with their consent.

Question Development

The content and face validity of the questions were measured by two experts (senior lecturers), a clinical pharmacist, and a paediatrician. Semi-structured questions were asked to all participants during the one-hour fruitful discussion. The interview guide is included in Table I.

Data Collection and Analysis

The selected participants were emailed a set of printed information sheets that included the title of the study, the study objective, the research question, and the role of the researcher. Following that, three dates were given to the participant so that they could choose a date that would be convenient for the FGD to be conducted. Furthermore, a phone call was placed to ensure the time and online platform for the discussion would be convenient for the participant. Most importantly, participant's confidentiality of the information and their voluntary withdrawal from the study at any time was assured. Audio and visual recordings of the entire discussion with the participants were performed upon receiving informed consent.

The focus group session was carried out on the agreed-upon online platform (Microsoft Teams). The moderator of the FGD was the principal researcher of this study and was the sole person involved in conducting the discussions. Firstly, a general question was posed to all the participants to allow them to be comfortable and feel safe sharing their opinions with others. Moreover, the topic was delivered by the moderator based on the guidelines of the focus group.[10] The moderator ensured that all participants were given an equal opportunity to share their opinions. Before the discussion, the participants in each group were asked to fill out a demographic questionnaire and consent form. A total of

Table I : Research Instrument (Focus group discussion questions)

No.	Opening Question
1.	What is your opinion regarding the usage of liquid medication among children?
	Knowledge And Practice
2.	What is your understanding on the time period (dosing interval) of administration of liquid medication to your child?
3.	In your opinion, what dosage instrument do you believe is accurate in measuring the dose and why?
4.	Why do you think it is important to follow storage instructions for liquid medications?
5.	How do you store liquid medication before and after use?
6.	What is your opinion regarding the safety of disposal of liquid medication?
7.	How do you dispose unused or expired liquid medications?
8.	In your opinion, explain how instructions for reconstitution of liquid medications should be communicated to the caregiver for better understanding?
9.	Describe the process of reconstitution and storage of reconstituted liquid medication that you practice?
10.	What are your views on the role of healthcare providers in providing information related to liquid medications?
11.	What is your opinion, regarding the types of information that you believe that should be delivered by the healthcare provider ?
	Closing Question
12.	Of all the things we have discussed today, what is the most important for you?

12 questions were asked to all participants during each FGD.

Saturation was achieved when no additional information was obtained in the FGD. The researcher was able to obtain information from the caregivers on the handling of liquid medications based on five pre-defined themes: dosing, storage, disposal, reconstitution, and expectation. Following each discussion, the researcher generated a transcript in preparation for data analysis using the thematic content analysis methodology. The audio recordings of all focus groups were transcribed verbatim by the principal researcher. Then, the researcher used NVivo 12 software (released in 2018)11 to generate initial codes and then key themes and subthemes were developed. The transcription and coding were then rechecked by two other researchers. Figure 1 illustrates the study flowchart for this study.

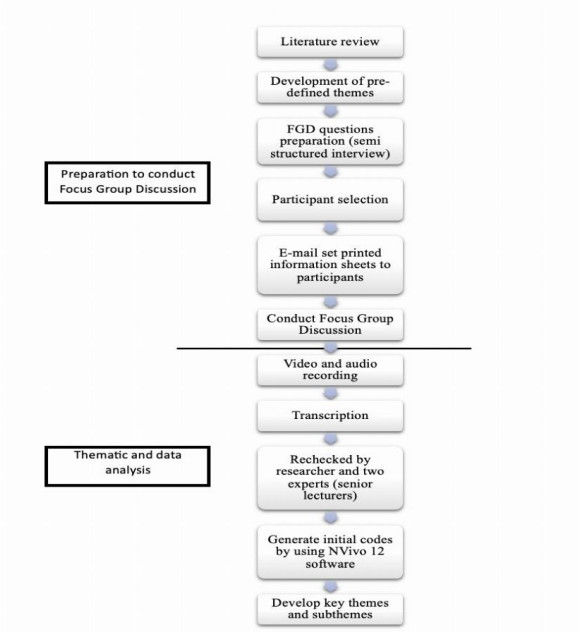

Figure 1 : Study Flow Chart. It also contains a flowchart outlining the steps taken to prepare for the Focus Group Discussion as well as data and thematic analysis.

Ethical considerations

Ethical approval for the study was granted by the Jawatankuasa Etika Penyelidikan Manusia Universiti Sains Malaysia (JEPeM-USM). The JEPeM USM Code for this study is USM/JEPeM/21110727.

RESULTS

Table II shows the characteristics of the study participants. The caregivers who took part in the study consisted of 4 male and 38 female participants, ages 20-70. A total of 5 key themes (dosing of liquid medications, storage of liquid medications, disposal of unused or expired liquid medications, reconstitution of dry powders, and expectations of caregivers) were identified. Figure 2 illustrates the conceptual framework (themes and subthemes).

THEME 1 DOSING OF LIQUID MEDICATIONS

Dosing errors such as overdosing and underdosing are common causes of adverse drug events. These can

Table II Characteristics of Study Participants (N= 41)

Variable characteristic	Frequency, n (%)
Gender	
Female	38 (90.4)
Male	4 (9.52)
Age range (years)	
20 - 30	5 (11.9)
31 - 40	21(50)
41 - 50	10 (23.8)
51 - 60	5 (11.9)
61 - 70	1 (2.4)
Number of children	
1	10 (23.8)
2	12 (28.6)
3	8 (19.05)
4	8 (19.05)
5	4 (9.52)
Education level	
Primary/Secondary school	8 (19.05)
Diploma	4 (9.52)
Degree/Postgraduate degree	30 (71.43)

occur due to inappropriate usage of dosing instruments, inadequate knowledge of dosing intervals, the wrong practice of missed doses, and the practice of mixing medications with beverages may result in drug-food interactions. Caregivers' practices and views on this were thus explored in this study.

Sub-theme 1 Preference of dosing instruments

Parents and caregivers expressed their opinions regarding the accuracy and feasibility of using the dosing instruments based on their experience. Most caregivers prefer syringes due to their convenience and accuracy of measurement.

We always use a syringe, focusing on the dosages because there is an indicator for one millilitre, two millilitres, and three millilitres. (participant x, FG 1).

I prefer to use syringes because there are measurements up to 5ml and it is easier to measure and feed them. Before this, I had used a dosing cup for 2.5ml measurements, but I still prefer a syringe. (participant w, FG 9).

Although the syringe is the dosing tool that caregivers most frequently mention using for dose administration, some caregivers also prefer to use a dosing cup for older children (above 6 years old).

I feel that is also a good one, but practically, I can't just feed the kids with the measuring cup because, I mean, for infants, of course, you can't do that, but for some kids, like from one year and above, I think they are good with that, but of course, I still prefer using the syringe compared to the dosing cup for children younger than 6 years old. (participant m, FG 8).

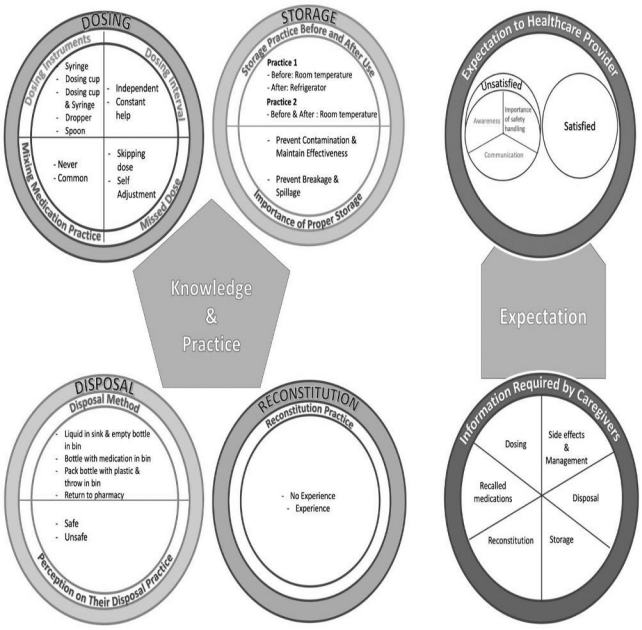

Figure 2 : Conceptual Framework (Themes and Sub-themes). The conceptual framework contains themes and subthemes found in the Focus Group Discussion that were held.

Some of the caregivers stated that they prefer to use the syringe and dosing cup concurrently to obtain an accurate dose.

Usually, I use the dosing cup first to measure the volume, then I use the syringe later to take the medication and adjust the dose using it. (participant p, FG 3).

Sub-themes 2 Knowledge on dosing interval

The caregiver's knowledge of the dosing interval, if the medication is prescribed to be taken two, three, or four times daily, was explored. Some caregivers were independent in determining the dosing interval of the prescribed medication.

For two times a day, I will set the time according to my available time since I'm working. Two times a day is 12-hour interval and three times a day is 8- hour interval. I will write down the timing so that I can remember when to administer. (participant c, FG 3).

However, some caregivers stated that they need help from healthcare providers to determine the dosing interval for the medications and they were not able to give the correct explanation.

If it's two times a day, then I believe it's 8 hours apart and if it's three times a day, it's supposed to be 4 hours apart.

Every four hours, you have to give them the medicine. (participant m, FG 8).

For me, I just follow the doctor's instructions or the label sticked by the pharmacist. I just make sure to follow the instructions given. (participant n, FG 4).

Sub-theme 3 Practice for the missed dose

Caregivers described missed dose management, which includes skipping the dose. When asked for further explanation, caregivers stated that they would skip and take the next scheduled dose.

I'll just continue with the next dose. For example, if I am supposed to give three times, I'll skip to two times since I forget. I would skip because if I give in between, then it will be an overdose.(participant f, FG 7).

Some caregivers explained that they will administer the dose as soon as they remember and then self-adjust the timing for the next dose.

Forgetting to take a dose is normal. If I forget, I will make sure to give it as soon as I remember and ensure to complete it until they feel better. Same for antibiotics; I will ensure to complete the course of antibiotics. (participant n, FG 4).

Sub-theme 4 Mixing medication practice

A general question regarding the caregiver's practice of mixing beverages or food with liquid medications was explored. Mixed responses were obtained regarding medication mixing with beverages such as juices, milk, and milo. Some caregivers stated that they do not prefer to administer the medications by mixing them with beverages.

So far, I haven't tried this, but sometimes doctors advise to just mix juice or milk if they don't want to take the medicine, but I don't want to try it because I'm worried. (participant p ,FG 7).

Never. If we give like that, they will adapt to that taste, and they'll be a phobia for the children in the future. So, every time we want to give them the medication, we will have a lot of problems giving it to them. I have never done that, and I find that's not right to do. (participant y, FG 9).

Caregivers shared their difficulty administering medications to their children due to the bitter taste.

I also mix medication into drinks, but I usually mix it with milo because they enjoy drinking it. This is because my child is aware that I will usually mix the medicine with milk, so they don't drink. And I cannot mix all the different types of medications, such as fever, flu, and antibiotics, in the milk because the smell and taste are bad. So, in that case, I will mix maybe only two medications together and a smaller amount of the medication too. It's very difficult to administer the medication to my child. (participant b, FG 2).

THEME 2 STORAGE OF LIQUID MEDICATIONS

The storage practice for all liquid medications before and after use was explored.

Sub-theme 1 Storage practice of liquid medications before and after use

The practice of storing liquid medications in the refrigerator after use was described by the caregivers.

After opening, I will store it in the fridge, and during traveling I will keep it in the shady place, when in the car. (participant d, FG 3).

Caregivers also mentioned that they will always store antibiotics in the refrigerator.

As for me, I'll check with the pharmacist before heading home. However, I rarely buy from the pharmacy. So, before I leave, I double-check where I need to keep the medicine. I always follow the doctor's advice on which should be stored at room temperature, and which should be stored in the refrigerator. I usually keep the antibiotics in the refrigerator. (participant j, FG 1).

Some caregivers practise storing the liquid medications at room temperature before use.

For me, I store it in a cabinet that is away from sunlight because I don't want it to be too hot or too cold because, usually, I notice the temperature that is suitable for the medicine by reading the instructions at the back of the medicine. (participant h, FG 5).

Sub-theme 2 Reasons on the importance of proper storage

The caregivers gave two main justifications as to why it is crucial to store medications properly. Some gave the justification of avoiding contamination and maintaining efficacy.

I agree. Some medicines contain preservatives, and some do not. So, some without preservatives will be damaged, and bacteria or fungus will be present. (participant t, FG 1).

I agree too. If not stored properly, the medicine can spoil and cannot last longer. I have seen fungus growth in my medicine because I did not store it properly. (participant d, FG 3).

The prevention of breakage and spillage of the fragile liquid medication packaging was one of the reasons given by several caregivers for the importance of proper storage.

The storage of liquid medication is very important because the liquid medication can easily spoil if the proper storage temperature is not followed. Besides that, the liquid medication can easily spill out of the bottle. So, we have to make sure to handle the liquid medication bottle properly and make sure that the cap is tightly closed. (participant s, FG 4).

THEME 3 DISPOSAL OF UNUSED OR EXPIRED LIQUID MEDICATIONS

Sub-theme 1 Method used for the disposal of unused and expired liquid medication.

In this study, the disposal methods utilised by caregivers for unused and expired medications were explored. Some caregivers described their practice of first emptying the liquid in the sink before dumping it in the trash.

I never throw the bottle containing the medication in the bin. What I will do is dilute the leftover medication in the bottle with water, pour it out, and then throw the empty bottle away. Safety practices for liquid medication disposal are very important. (participant y, FG 9).

Some caregivers mentioned that they either directly dump the unused or expired liquid medications or pack them in a plastic bag before dumping them in the trash due to their limited time.

I throw it directly into the bin, but I will separate it from the other rubbish. I usually will not pour in the sink because the cleaning process will be difficult. (participant e, FG 3).

Whether it is pills or liquid medications, I will just pack them in a plastic bag and throw them away, because I believe that once they are packed in a plastic bag, they are secure and safe. I will pack them in two plastic bags. (participant h, FG 5).

Only a small percentage of caregivers stated that they returned the unused medication to the pharmacy.

If I have time, I'll take it back to the pharmacy and pass it to the pharmacist so that they can throw it in the recycle bins. Generally, I dispose the medicine in the sink and the bottle in the rubbish bin, but if time permits, I dump it at the special facilities. I'll save all the medications and bring them to the pharmacy at once. (participant a, FG 5).

Sub-theme 2 Perception on their disposal practice

When further asked about their perception if their method of drug disposal is safe or unsafe, many caregivers were unsure about their drug disposal practice.

There isn't exactly a special kind of system and facility in Malaysia. For example, the chemical can be disposed of in specially designated areas. But liquid medications which come in smaller quantities don't have a specific way for disposal, so I think pouring the liquid medication in the sink is a safe way. (participant z, FG 10).

I agree with them too. We don't have much knowledge of this. Maybe the way we are disposing of is not safe. No one let us know about this, so we just use a logical way to dispose of it. (participant c, FG 3).

Caregivers who practise dumping directly believe that it is an unsafe method and are unsure which is safer.

I think we have to return it to the pharmacy, but I don't practice this. I just throw it directly in the bin. I think my method of disposal is not safe. I think pouring it in the sink would be safer, but we don't follow that either. (participant v ,FG 2).

THEME 4 RECONSTITUTION OF DRY POWDERS

Caregivers described the type, temperature, volume of the diluent, and storage of the reconstituted medication.

Even before leaving the clinic, I will seek the person's advice on the method, but when I return, I will read the instructions on the bottle again. I'd like to go over the actual method again because we sometimes forget. If they said 60 ml, then it's 60 ml and the water temperature is room temperature and I shake it well so that it dissolves and usually reconstitute means it's an antibiotic, so after mixing it, I'll keep it in the fridge. (participant g, FG 1).

THEME 5 EXPECTATIONS OF CAREGIVERS

Sub-theme 1 Expectations to the healthcare provider

This study also looked at how satisfied the caregivers were with the healthcare provider's performance. Caregivers emphasised the lack of communication by healthcare providers, which leads to incomplete and inaccurate information.

Yes, I think they lack communication too. Sometimes I feel like they don't tell us the complete information, so we must ask them, and only then they let us know. I think it's their responsibility to let us know whatever information is important. I understand that it is t ime-consuming with many patients, but I hope the important information is delivered to us. (participant k, FG 7).

Sub-theme 2 Information required by caregivers.

Caregivers believe that there are many important types of information required to practice the safe handling of oral liquid medications among children, including information on the common side effects and their

management, information on dosing, information on redosing in case of vomiting, and information on missed doses, which should be provided by healthcare providers while dispensing medicines to caregivers.

As you asked me just now, if I miss a dose, what will I do so? I've never come across anyone who's like, saying if you skip this dose, you must do this and this. I have never come across that before, so maybe they could improve themselves by doing it, explaining to us what to do if they skip the dosage and all. If the baby vomits the medicine, can I give them back the medication or should I just keep that dosage. (participant q, FG8).

Same too. The exact amount that I should give to the kids, how I should store the medication, and the effects of the medications. Usually, I must ask the doctors what the side effects of the medications prescribed are. So, this type of information is important. This is because if I am about to search for information regarding the side effects of the medication on the Internet, then that is a different story, so I do prefer getting this kind of information directly from the doctor or any healthcare professionals. (participant r, FG8).

DISCUSSION

This study has identified a total of five key themes and 10 sub-themes regarding the caregiver's knowledge and practice in handling oral liquid medications in children. Overall, caregivers in our study have fair knowledge and practice in accurate dosing while administering liquid medications to their children. This is because most caregivers administer liquid medication by using appropriate dosing instruments such as syringes and dosing cups and are more careful when measuring the dose for their children. The findings were in line with the published study, where the majority (80.5%) of caregivers always use oral syringes to administer liquid medication to their children.[12] To promote dosing accuracy, the American Academy of Pediatrics (AAP) and the US Food and Drug Administration (FDA) also advise parents to use dosing tools with standard markings (e.g., oral syringes, droppers, and dosing cups) rather than nonstandard kitchen spoons, which differ greatly in size and shape. In situations where precision is crucial, oral syringes are regarded as the gold standard.[13] However, dosing cups are generally associated with more errors compared to oral syringes, particularly for small doses. The high number of errors from using dosing cups is mainly due to the wrong eye position when reading the volume of liquid medication in the dosing cup.[13] Based on the study conducted in Saudi Arabia, the majority of the study participants (58%) measured the dose of liquid paracetamol accurately by using the dosing syringe compared to the dropper (50%) and dosing cup (51%).[14] It was evident that participants who used a dosing cup, measured more than the dose required, whereas when the dropper was used, it measured less than the required dose. In a recent study, 39.4% of the parents made an error while measuring doses and those who used teaspoons or tablespoons were twice as likely to measure incorrectly compared with those who measured using millilitre-only devices. Thus, devices with standard markings are considered accurate for administering liquid medicines to children.[15]

Most caregivers are independent in determining the correct dosing interval according to the dosing frequency since the majority are degree holders; however, some caregivers still lack knowledge of it. This finding contradicts the study conducted in Palestine, where only 28.8% of mothers follow the correct practice by administering the medication every 8 hours and 56% of them reported giving drug doses with major meals (breakfast, lunch, and dinner) with no regard for spacing between doses.[16] Moreover, a cross-sectional study conducted in Turkey found that most parents who did not have (or not given) enough educated awareness had the wrong dosing interval practices.[17] Thus, caregivers who require constant help in determining the dosing interval between each dose need assistance and instructions from healthcare professionals before administering liquid formulations to their children. According to an Australian study, incorrect or double dosing accounted for 58% and 26 % of cases of medication errors among children, respectively. The majority of these errors (98%) were made by caregivers at home and occurred via the oral route (98.4%). Preventive measures like improvement in literacy status, proper comprehension of physician instruction, and demonstration of measurements by teach-back technique are thus crucial for better understanding among caregivers instead of verbal explanation in reducing medication errors.[18]

According to several studies, parents or healthcare professionals have reported that children may have poor acceptance, particularly due to the taste of the medication.[19] The majority of caregivers in our study do not practise mixing liquid medications with foods or beverages; however, some still do so to make medicines more palatable for their children. These caregivers practise mixing them with their children's favourite beverages, such as milk or juice. This finding is in line with the study conducted in Palestine, where it was reported that a minority of the caregivers still practice administering the liquid medications with milk (4.7%), food (5.2%), and juice (21.5%) when they refuse to take them.[8] Mixing oral drugs with juice, milk, or fruit is an incorrect practice that may affect the serum concentrations of some drugs. A study conducted by Kane and Lipsky also reported that serum concentrations of some drugs, such as cyclosporine, tacrolimus, and carbamazepine were elevated if consumed with grapefruit juice.[8] Similarly, milk may decrease the absorption of various antibiotics such as quinolones and tetracyclines as well as the bioavailability of non-steroidal anti-inflammatory drugs and proton pump inhibitors.[20]

Thus, mixing medicines with food or beverages should be avoided as it may affect the stability, solubility, and bioavailability of administered medicines, resulting in subtherapeutic or even toxic drug levels.

Majority of the caregivers have proper practice for the storage of liquid medications before and after use. Furthermore, several stated that they would also read the storage instructions on the label before directly storing them in the fridge. In addition, all the caregivers stated that they would store the antibiotics in the fridge after use. This shows that they are extra cautious when handling antibiotics. This finding is in line with the previous study, where the majority (44.2%) of caregivers stored suspension antibiotics in the fridge.[16] Besides that, the findings reported that majority of the caregivers store the other liquid medications at room temperature before use and in the refrigerator after use. When medications are stored at temperatures, either too high or too low, their chemical stability will be impaired. This means that the drug may degrade and form impurities. While these impurities may not be visually noticeable, this degradation can cause real problems when the drug is administered.[21] Appropriate and safe storage of medicine at home is thus crucial, as it helps prevent contamination and the breakage and spillage of liquid medicines.

The majority of caregivers practise emptying the liquid medications into the sink before dumping them. Contrary to the findings of this study, most participants (50%) in a study conducted in New Zealand disposed of unwanted or expired medicines in household trash, whereas 39% dumped them down the sink.[22] Despite knowing that dumping the medication directly is unsafe, caregivers are unsure of how to dispose of it safely. This finding is consistent with the published study,[23] where 50% of participants believed that disposing of pharmaceuticals in the trash, toilet, or sink harms the environment, while the use of expired medicines can cause harm if administered to children due to medicine degradation resulting in toxicity or sub-therapeutic effects and thus require more information from healthcare professionals on safe disposal of liquid medications.[24]

Caregivers showed good knowledge and practice in reconstitution before administering liquid medicines to their children. When asked about the steps for the reconstitution of the medication, all of them followed the proper steps for the reconstitution, and most importantly, they emphasised the importance of following the instructions for the reconstitution. According to a study conducted in Palestine, the majority of the participant's mothers (75.5%) who prepared antibiotic suspension used boiled and then cooled water and 76.6% added water in two steps instead of one to prevent lumps, which are correct practices.[16]

Many of the caregivers stated that their expectations from the healthcare providers were unmet due to a lack of communication. Healthcare providers must effectively communicate with caregivers to ensure that information is conveyed in a way that increases the caregivers' knowledge and teaches proper handling of liquid medications. During the FGD, all caregivers shared their opinions on the types of information they believe should be provided by healthcare providers to have better knowledge and practice in handling oral liquid medications in children. The information required by most caregivers is on dosing. Next, information on the common side effects of specific liquid medications prescribed to the patient and their management is the second most requested information by the caregivers, followed by details on disposal, storage, reconstitution, and a list of recalled medications, respectively. A published study conducted in Malaysia highlighted suggestions shared by caregivers that should be followed by healthcare practitioners to increase drug safety.[1] Firstly, they stated that they need more details on the indication, dose, frequency, length of treatment, and generic name of medication prescribed to their kids by medical professionals. To ensure continuity of care and to receive accurate information about the prescriptions, the respondents also expressed a desire for their children to see the same doctors. In addition to the existing drug labels, some respondents suggested the use of written instructions as a reminder, particularly for prescriptions that are not to be used at a fixed dose.[1] Healthcare providers can educate the public on the importance and right method of liquid dosage administration, its storage, reconstitution, and disposal through social media, by putting up posters at the clinic, or during dispensing. Healthcare professionals and government organisations should collaborate to improve communication strategies to raise caregivers' awareness of medication safety, among caregivers such as (i) providing written medication information for better recall of information, (ii) using teach-back techniques to see if caregivers have understood instructions, (iii) avoiding giving too much information all at once, (iv) using interpreters for those with a language barrier and (v) providing measuring equipment for improved adherence and correct administration of medication at home.[25]

CONCLUSION

Most caregivers have adequate knowledge and practice in dosing, storage, disposal, and reconstitution; however, some only have suboptimal proficiency with handling oral liquid medications. Therefore, this implies that there is room for improvement for caregivers with suboptimal levels of knowledge and practice. Furthermore, most caregivers are dissatisfied with the lack of communication from healthcare providers. Thus, healthcare providers have a crucial role in increasing awareness and providing adequate, accurate, and most importantly, comprehensive information to caregivers on handling oral liquid medications which includes dosing, side effects and their management,

proper disposal techniques, storage, and reconstitution. This will assist caregivers with the self-care of their children, improve self-medication management, build confidence in their practice, reduce the likelihood of adverse effects and hence their economic burden.

STRENGTH AND LIMITATIONS

There are several limitations to this study. Firstly, there is a limitation to the generalizability of the study. This qualitative study includes a total of 42 participants who were recruited through snowball sampling and may not represent the rural areas' varying levels of knowledge and practice altogether. Participants from rural areas were not able to be recruited due to limited resources (poor internet connection, no laptop or computer, or smartphones). As a result, the findings are not generalizable to all populations of caregivers. However, a qualitative approach was implemented in this study because it provides new insights and understanding regarding liquid medication handling among children, which may be useful for both healthcare professionals as well as policymakers.

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REFERENCES

1. Chew C chii, Chan H keat, Chang C tao, Hss A singh, Hassali M azmi. Medication-related knowledge, administration practice and adherence among caregivers of chronically ill children in Malaysia. BMC Pediatr. 2021;21(1):1-9. doi:10.1186/s12887-021-02691-3
2. Ranmal SR, O'Brien F, Lopez F, et al. Methodologies for assessing the acceptability of oral formulations among children and older adults: a systematic review. Drug Discov Today. 2018;23(4):830-847. doi:10.1016/j.drudis.2018.01.038
3. Chan HK, Hassali MA, Lim CJ, Saleem F, Tan WL. Using pictograms to assist caregivers in liquid medication administration: A systematic review. J Clin Pharm Ther. 2015;40(3):266-272. doi:10.1111/jcpt.12272
4. Brennan L, Vázquez A, Gallegos J, Koninckx M, Marco J, Huerta S. A study of medication errors during the prescription stage in the pediatric critical care services of a secondary-tertiary level public hospital. BMC Pediatr. 2020;20(1):1-8.
5. Feyissa D, Kebede B, Zewudie A, Mamo Y. Medication Error and Its Contributing Factors Among Pediatric Patients Diagnosed with Infectious Diseases Admitted to Jimma University Medical Center, Southwest Ethiopia: Prospective Observational Study</p>. Integr Pharm Res Pract. 2020;Volume 9:147-153. doi:10.2147/iprp.s264941
6. CDC - Patient Safety- Homepage. https://www.cdc.gov/patientsafety/features/safe-medicine-children.html. May 12, 2023.
7. Rautamo M, Kvarnström K, Sivén M, Airaksinen M, Lahdenne P, Sandler N. A focus group study about oral drug administration practices at hospital wards—aspects to consider in drug development of age-appropriate formulations for children. Pharmaceutics. 2020;12(2):1-13. doi:10.3390/pharmaceutics12020109
8. Ali R, Shadeed A, Fitian H, Zyoud SH. The difficulties experienced during the preparation and administration of oral drugs by parents at home: A cross-sectional study from Palestine. BMC Pediatr. 2020;20(1):1-8. doi:10.1186/s12887-020-02105-w
9. Bergene EH, Rø TB, Steinsbekk A. Strategies parents use to give children oral medicine: a qualitative study of online discussion forums. Scand J Prim Health Care. 2017 Jun 5;35(2):221–8.
10. O.Nyumba T, Wilson K, Derrick CJ, Mukherjee N. The use of focus group discussion methodology: Insights from two decades of application in conservation. Methods Ecol Evol. 2018;9(1):20-32. doi:10.1111/2041-210X.12860
11. NVivo [Internet]. QSR International Pty Ltd. (2018); Available from:https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home
12. Bakhtiar SZ, Li KS. Parental knowledge and practice on liquid medication for the use of children at home. Sarawak J Pharm. 2020;6(3):93-97.
13. Shonna Yin H, Parker RM, Sanders LM, et al. Liquid medication errors and dosing tools: A randomized controlled experiment. Pediatrics. 2016;138(4). doi:10.1542/peds.2016-0357
14. Almazrou S, Alsahly H, Alwattar H, Alturki L, Alamri M. Ability of Saudi mothers to appropriately and accurately use dosing devices to administer oral liquid medications to their children. Drug Healthc Patient Saf. 2014;7:1-6. doi:10.2147/DHPS.S72315
15. Johnson A, Meyers R. Evaluation of measuring devices packages with prescription oral liquid medications. J Med Educ. 1953;28(4):19-23. doi:10.1378/chest.85.4.457
16. Al-Ramahi RJ, Zaid AAN, Anabousi H. Problems associated with reconstitution, administration, and storage of antibiotic suspensions for pediatrics: A cross-sectional study in Nablus city, Palestine. BMC Res Notes. 2015;8(1):4-9. doi:10.1186/s13104-015-1746-z
17. Boztepe H, Özdemir H, Karababa Ç, Yıldız Ö. Administration of oral medication by parents at home. J Clin Nurs. 2016 Nov;25(21–22):3345–53.
18. Sil A, Sengupta C, Das A, Sil P, Datta S, Hazra A. A study of knowledge, attitude and practice regarding administration of pediatric dosage forms and allied

health literacy of caregivers for children. J Fam Med Prim Care. 2017;6(3):636. doi:10.4103/2249-4863.214433
19. Sharaideh R, Wazaify M, Albsoul-Younes AM. Knowledge and attitude of school children in Amman/Jordan toward the appropriate use of medicines: A cross-sectional study. Saudi Pharm J. 2013;21(1):25-33. doi:10.1016/j.jsps.2012.01.001
20. Palleria C, Di Paolo A, Giofrè C, et al. Pharmacokinetic drug-drug interaction and their implication in clinical management. J Res Med Sci. 2013;18(7):600-609.
21. SciSafe. Understanding the Importance of Temperature Control in Pharmaceutical Stability. https://scisafe.com/understanding-the-importance-of-temperature-control-in-pharmaceutical-stability/#:~:text=When a drug is stored,when the drug is administered. Published 2019.
22. Naidu R, Bassett-Clarke D, Nicholson R, Tordoff J. Parents and caregivers experience in managing children's medicines after discharge from a New Zealand hospital. New Zealand Medical Journal. 2022 Aug 5; 135(1559). ISSN 1175-8716 www.nzma.org.nz/journal
23. Paut Kusturica M, Tomas A, Horvat O, Tomić Z, Sabo A. Storage and Disposal of Unused Medications: Knowledge, Behavior, and Attitudes Among Serbian People. Clin Ther. 2015;37(8):e27-e28. doi:10.1016/j.clinthera.2015.05.086
24. Rogowska J, Zimmermann A. Household Pharmaceutical Waste Disposal as a Global Problem—A Review. Int J Environ Res Public Health. 2022;19(23). doi:10.3390/ijerph192315798
25. Naidu R, Bassett-clarke D, Nicholson R, Tordoff J. Parents and caregivers experience in managing children's medicines after discharge from a New Zealand hospital. Newzeal Med J. 2022;135(1559):8-23.