IMPROVING THE ACCURACY OF LIQUID MEDICATION DOSE MEASUREMENT USING ALTERNATIVE DOSING DEVICES IN A SELECTED BARANGAY IN PAMPANGA: A BASIS FOR AN INTERVENTION

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ABSTRACT

The objective of this study was to assess the abilities of parents or guardians of pediatric patients in measuring the correct amount of oral liquid medications using alternative dosing devices available at their household and to propose an intervention plan which directly intended to make improvements on their practices. A descriptive research design with supporting action research components was used to identify solutions that are particular to the problems in parents or guardians' dosing practices. Thirty (30) parents or guardians participated in the study and it was revealed that most of them preferred the use of measuring cups in measuring oral liquid medications and their actual dosing rate was predominantly overdose. It was found that the most encountered problem by the participants during the liquid medication measurement was the illegibility of printed labels on the measuring devices and it was also found that based on their own perception, participants need guidelines or detailed dosing instructions and a proper or standard dosing device to improve their measuring abilities. The researcher proposed an intervention plan which tends to support the aim of the study to improve the parents or guardians' oral liquid medication dosing abilities upon learning the problems encountered and the things needed by the participants.

Keywords: *alternative dosing devices, oral liquid medication, pediatric patients*

INTRODUCTION

Drugs are made available in an extensive variety of dosage forms caused by continual innovations. One common dosage form that is readily available in pharmacies is the oral liquid medication. Pediatric patients are primarily the consumers of these oral liquid medications which suit them the most to resolve their swallowing difficulty.

In Chang, Chen, Chang, and Smith (2010), it was noted that administering the right medication is an important issue in patient safety and that ensuring that the right patient receives the right dose is one of the best self-defenses against medication errors. However, as long as human beings are involved in the process of medication use, errors are inevitable.

Most errors reported in studies involving oral liquid medications were due to faulty measurements of the liquid medication, unable to comprehend instructions by some parents, and noncompliant to the said regimen which can increase risk for mortality and morbidity. One cause of medication errors is due to inaccurate dosing using measuring devices. Dosing devices are provided by the manufacturers which they include in the packaging of the drug. However, some drugs do not include these dosing devices with their

products. Spoon dosing or the use of a household tablespoon and teaspoon is a common option for mothers if a measuring device is unavailable.

As a practicing community pharmacist in the Philippines, the researcher is aware that the use of kitchen tablespoon and teaspoon is tempting to parents because many liquid medications, particularly over-the-counter (OTC) drugs, and some doctors' prescriptions are based on medication dosage using teaspoon and tablespoon which can lead to another medication error.

The American Academy of Pediatrics (AAP) supports the recommendation of using metric dosing for oral liquid medications. Metric-only labeling is also supported not only for OTC liquid preparations but also for electronic prescribing systems by the AAP in a 2013 policy statement entitled Electronic Prescribing in Pediatrics. It was recommended that the use of tablespoon and teaspoon should be avoided to be able to reduce errors and increase accuracy in administering liquid medications. Milliliter-based with metric marking dosing devices preferably syringes is encouraged to be used in prescribing and administering the liquid drug (Paul, 2015).

Paying attention to medication administration in pediatric patients can decrease errors and prevent possible adverse effects. Parents play an important role towards the child's therapy. A child's compliance with the medication depends primarily on the parents as they are said to be the connection between the child and the prescriber. Parental education status plays a big factor in drug administration because a parent should understand the instructions given to carry out the right procedure to prevent any error that can jeopardize the child's health. (You et al., 2015).

Dosing errors can greatly affect the optimization of pediatric health, safety and well-being. Hence, the assessment of the practice of parents in liquid medication dose measurement using alternative dosing devices must be done.

This study may help to determine what alternative dosing devices are commonly used by parents of pediatric patients and are available in their households. This can assess the rate of medication dose errors in administering oral liquid medication with the use of various dosing devices. It may also educate parents and the community on the proper use of dosing devices in measuring oral liquid medications and may inform them that dose administration that is either greater or less than the amount intended may have a negative effect especially on a pediatric patient.

The success of this research will benefit mainly the pediatric patients through the improvement of the parents and guardians' practices in measuring oral liquid medications to prevent any toxicities or treatment failures. This may also educate the parents and the community on how to accurately measure liquid medication using a dosing device.

Review of Related Literature

Liquid Medication Error

The United States Poison Control Centers (US PCCs, 2012 as cited in Smith, Spiller, Casavant, Chounthirath, Brophy, & Xiang, 2014) reported that there are 696, 937 out-of-hospital medication error exposures among children less than 6 years of age from 2002 to 2012, which averages 63,358 exposures per year or 26.44 exposures per 10,000 populations. Confusing units of measurement or an incorrect amount dispensed are some of the factors that cause medication errors in liquid preparations, which were not experienced with other formulations (Smith et al., 2014).

Wrong Dose Caused by Human Factor

It was reported that there is a high number of medication errors pertaining to liquid medications where a number of 5,366 medication errors tailed in most of the international studies and researchers. It was found out that the most common error scoring 41% was the administration of the wrong dose of the drug to a patient. Through evaluation of the cause of errors, it was found that 65% involved human factor. It was defined as knowledge and performance deficits on the part of the prescriber, pharmacist or patient that resulted in inappropriate administration technique. Most errors reported

were due to faulty measurements of the liquid medication, unable to comprehend instructions among parents, and noncompliant to the said regimen which can increase risk for mortality and morbidity (Karch, 2003).

Wrong Dose due to Dosing Devices

Several types of devices are used to measure liquid medication. Studies have found that a considerable proportion of patients or caregivers make errors when measuring liquid medication with dosing devices. In measuring doses of liquid medication, there is approximately one out of 10 participants that measured dose of liquid medication with a volume error. These errors were common with the etched dosing cup, the dosing spoon and the printed dosing cup. Liquid medication dosing errors pose a risk to patients from sub-therapeutic doses and overdoses (Ryu & Lee, 2012). The U.S. Pharmacopeia (2008) specified that the volume incurred in measuring liquids for individual dose administration by means of such calibrated devices should not be greater than 10% of the indicated amount.

A new voluntary guideline in response to the reports of unintentional drug overdoses was released by the US Food and Drug Administration (FDA) (2009). In Yin, Wolf, Dreyer, Sanders, and Parker (2010), the assessment of the uniformity in dosing instructions and various measuring devices among pediatric OTC medications was included when the US FDA's guidelines were released. Out of the 200 products, 148 were enclosed with a measuring device. Inconsistencies between the medication's dosing directions and markings on the device were found in 146 cases. These include missing markings and superfluous markings. Across all products, 11 used atypical units of measurement (e.g., drams, cc). Milliliter, teaspoon and tablespoon units were used for the dose of liquid medications. This indicated that common OTC pediatric liquid medications frequently contained conflict and differences between the markings on the dosing devices and volumetric dosing instructions on the printed label. When the FDA released this regulation, top-selling pediatric OTC liquid medications still contained conflicting dosing instructions and imprinted labels on measuring devices (Yin, et al., 2010).

Household spoons

In Bayor, Kipo and Kwakye (2010), the different types of household spoons which are currently used in Ghana were determined. It was found that most of the participants preferred the use of household spoons in measuring liquid rather than the enclosed dosing device. The use of household spoons was the standard in measuring oral liquid medication, where tablespoon and teaspoon were labeled and accepted to measure 15 ml and 5 ml, respectively. Many of the liquid medications do not contain enclosed dosing devices, thus, directions on the use of household spoons as measuring devices are still being given to patients. These are also seen in packaging labels of the liquid medications.

In Falagas, Vouloumanou, Plessa, Peppas, and Rafailidis (2010), tweny-five (25) women were asked to collect tablespoons or teaspoons which were evaluated by measuring the volume capacity (ml in water) of each. The participants provided a total of 71 teaspoons and 49 tablespoons. On one hand, the volume capacity of the 71 measured teaspoons ranged from 2.5 to 7.3 ml, which led to a measurement of 4.4 ml in median and mean volume. On the other hand, 49 measured tablespoons ranged from 6.7 to 13.4 ml that resulted to a mean volume of 10.4 ml and median was 10.3 ml. In a subset of five studies, participants filled the teaspoon with Paracetamol syrup in which the mean was 4.8 ml. The chance that a child is receiving an overdose or indeed too little medication increases in this case.

The use of teaspoons is associated with significant dosing errors and by avoiding the use of teaspoons in measuring liquid medicine, dosing errors are minimized (American Academy of Pediatrics, 2011). It was found that doctors and pharmacists encourage the use of teaspoons and tablespoons as the measuring unit at times when instructing caregivers.

The US (2009) recommends avoiding the usage of kitchen utensils in administering and measuring liquid medicines. Spoon dosing has been identified as a major cause of dosing errors that can result to pediatric poisonings. One hundred ninety-five (195) university students who were recent patients at a university health clinic, were asked to dose 5 ml of cold medicine into a teaspoon, medium-sized tablespoon and a larger spoon. The study showed the amount of cold medicine that the participants poured varied directly with the size of the spoon. They overdosed by 11.6% when using the larger spoon and under dosed by 8.4% when using the medium-sized spoon considering that the participants were confident that their pouring method was accurate and equally effective. Due to the variability of the volume capacity of household tablespoons and teaspoons, it can lead to under or overdosing which results to consequences such as reduction in the expected clinical efficacy and it may cause more adverse events (Wansink & van Ittersum, 2010)

Measuring cups, Droppers and Syringes

In Yin, Dreyer, Ugboaja, Sanchez, Moreira, and Mendelsohn (2014), parents were observed by verbally being asked to measure 5 ml of acetaminophen suspension. Instrument order was randomized for each subject. Dosing errors were observed from the parents who used cups compared to dosing spoons, droppers or syringes. Proper and accurate use of measuring device and health literacy and counseling are some methods to reduce errors and should be given of importance.

In Sobhani, Christopherson, Ambrose, and Corelli (2008), participants (at least 18 years old above) were asked to measure a 5 ml dose of Tylenol (Acetaminophen) liquid medication using an oral syringe and a dosing cup provided by a manufacturer which were found to be the most commonly used devices of the participants at home for measuring liquid medications. An acceptable dose was defined as 5.0 ± 0.5 ml with a total of 96 subjects completed the study. It was found that sixty-six (66.7%) subjects measured an acceptable dose using the syringe versus 14 subjects (14.6%) using the cup ($p < 0.001$); thus, the subjects were more likely to measure an acceptable dose with an oral syringe when compared with a dosing cup. However, a large proportion of study participants were unable to measure an accurate dose with either device. Thus, community pharmacists should educate caregivers on the selection and proper use of measuring devices to improve the accuracy of medication administration at home.

The American Academy of Pediatrics (AAP) and the US Food and Drug Administration (FDA) with the huge desire to promote dosing accuracy, recommend that parents may use dosing tools with standard markings (e.g., oral syringes, droppers, dosing cups) instead of nonstandard kitchen spoons, which vary widely in size and shape. However, no national guidelines exist on the type of tool that should be provided to families. Several studies have found that cups which are frequently seen in most OTC products are associated with higher rates of parent errors. However, these were limited in scope particularly in the range of dose amounts tested and aspects such as complexity of tool markings. With this observation, oral syringes are considered the gold standard when accuracy is crucial (Yin, Parker, Sanders, Dreyer, Mendelsohn, Bailey & Wolf, 2016).

Parent's Role in Child's Medication Therapy

Medication administration errors are the most common type of error in pediatric medicine and parents play an important role towards preventing these errors to ensure safe and quality patient care for pediatric patients. In You, Nam, and Son (2015), 179 parents of pediatric patients in Korea participated in the study. The parents' administration of

medication to their children at home and the understanding of these parents of adverse drug events (ADEs) were observed and it was found that parents more commonly used dosing cups (43.6%) and droppers (32.9%) when administering liquid medication to children. Furthermore, 12.3% of the children experienced ADEs. Only 48% of the participants were provided information on ADEs, 15.1% were unsure about the recommended dosage, and 11.2% were unsure of the recommended method for administering the medication.

The study suggests how child's compliance with the medication depends primarily on parents as they serve as channel between the child and the prescriber. Parental education status plays a big factor in drug administration. It is important that a parent should understand the instructions given to carry out the right procedure to prevent any error that can jeopardize the child's health. Strategies are needed to reduce pediatric home medication errors and minimize ADEs and provide medication information to parents. This is the reason why parents or guardians of pediatric patients are the target respondents of this study.

Identifying Dosing Device Measurement Errors to Improve Health Care Delivery

Most of the common types of errors resulting in patient death involved the wrong dose (40.9%), the wrong drug (16%), and the wrong route of administration (9.5%). The causes of these deaths were categorized as oral and written miscommunication, name confusion (e.g., names that look or sound alike), similar or misleading container labeling, performance or knowledge deficits, and inappropriate packaging or device design (Hughes & Blegen, 2008).

Although considerable progress has been attained in making labeling improvements for adult medications, to date there has been limited work incorporating a pediatric perspective, despite the studies documenting parent dosing error rates of ≥40%. Lack of evidence regarding best practices has been a barrier to establishing standards related to the labeling and dosing of pediatric medications (Yin et al., 2016).

Since medication errors have significant implications on patient safety, error detection through an active management and effective reporting system discloses medication errors and encourages safe practices through an application of tailored preventive strategies (Elden & Ismail, 2015).

Based on various literature discussed, dosing errors are huge problem in healthcare delivery on pediatric patients. Dosing errors due to alternative dosing devices usage play a big role to this type of medication error. It was said that volume errors observed from liquid medication measured using different dosing devices may pose a risk to patients from sub-therapeutic doses and overdoses. Due to the significant dosing errors using kitchen utensils, the American Academy of Pediatrics (2011) recommends that the usage of these devices in measuring liquid medications must be avoided. Dosing errors were observed from the parents who used cups compared to dosing spoons, droppers or syringes after instructing the participants to measure 5ml of acetaminophen suspension (Yin, et al., 2014). The parents or guardians of pediatric patients are the target respondents of the study since supporting studies suggest how child's compliance with the medication depends primarily on parents. Despite the studies documenting parent dosing error rates, there is still lack of pieces of evidence regarding best practices to establish standards related to the dosing of pediatric medications which will serve as the purpose of this study.

An action research approach was utilized in this study seeking changes and improvement in parents and guardians' practices toward measuring oral liquid medications. The characteristics of an action research provide researchers with a framework for exposing group knowledge and planning with those most involved rather than imposing expert knowledge and planning. This will be achieved by working closely in the community involved with the issue, which has the most reliable information to solve these particular problems because community members are considered as the "insiders" or those who are living the

problem and have a unique understanding of it. The researcher upon working within the group would then try to understand or improve a situation identified by the group using systematic, analytical, and reflective techniques to gather data that lead to the development of an action plan for solving the problem based on the information gathered and in collaboration with those in the group (Hinchey, as cited in Streubert & Carpenter, 2011).

Research Objectives

This research study aims to produce action, in this case an intervention plan that is directly used to make improvements in the accuracy of liquid medication dose measurement using alternative dosing devices through education and community engagement. Specifically, it also aims to:

1. Determine the following:
    1.1. The alternative dosing devices available in the participants' households.
    1.2. The dosing rate accuracy (measured using a 10 ml pipette to determine the margin of error) produced by the participants when measuring a needed 5 ml sample using different dosing devices, specifically
        a. Household teaspoon;
        b. Household tablespoon;
        c. Oral Syringe;
        d. Measuring cup;
        e. Dropper; and
        f. Others
2. Determine problems encountered during dose measurement.
3. Propose action that is directly intended to make improvements on the participants' practices.

METHODOLOGY

Research Design

A descriptive research design was used to identify solutions to the problems particularly the parents' practices in measuring oral liquid medications using various alternative dosing devices available at their households.

The study consists of action research cycle components such as *Planning* which is the phase where the stakeholders or anyone affected in any way by the problem or the desired change. Upon identifying the stakeholders, the researcher then determined how the investigation proceeded and designed research methods and assessment procedures that were used to identify the problem and its solutions. *Acting* is the process of collecting the data using the questionnaires developed by the researcher. *Observing* is the stage where the data gathered were analyzed by the researcher and the key participants (Hinchey, as cited in Streubert & Carpenter, 2011). This joint activity enabled the entire research team (researcher and key participants) to bring its perspectives to the discussion providing the opportunity for dialogue and debate about the findings and their respective meanings. This group reflection brought clearer interpretations and explanations of the data collected and led to the development of an intervention plan which consists of solutions addressing the problems identified.

Participants and Setting

Purposive sampling was used to focus on particular characteristics of a population that is of interest and is based on the objective of the study. The participants who were selected are only either parents or guardians of children below 18 years old (oral liquid medications are recommended formulations for 18 years old below (Knoppert et al., 2007) residing at a selected barangay in Pampanga.

Individuals who were unwilling to demonstrate measuring the liquid samples were excluded. Key participants were selected based on the five criteria of eligibility. The first criterion is the *Role in the community* which is predetermined by acquiring the participants' data from the barangay hall. *Knowledge* is the criterion referring to a participant having specific information on a particular issue which the researcher wished to understand better. *Willingness* is another criterion referring to a participant's enthusiasm to communicate

knowledge and to contribute utmost cooperation. *Communicability* is also a criterion referring to a participant's ability to communicate knowledge in a manner that is comprehensible to the researcher. *Impartiality* is the last basis referring to a participant's being objective and unbiased. Relevant biases must be known by the researcher (Tremblay as cited in Marshall, 1996). Potential key participants were considered by the researcher on the basis of their ability to fulfill the selection criteria. The specific characteristics were evaluated by the researcher based on the initial interview and the observation to choose the most productive individuals among the participants. Subjects were given a written invitation for the scheduled meeting. The data were presented and analyzed which helped in identifying the needed intervention.

Instrument

A structured interviewer-administered questionnaire which was developed by the researcher was used for gathering of data specifically on the problems or factors verbalized by the participants and the volumes measured using the available dosing devices (household teaspoon, household tablespoon, syringe, measuring cup, dropper or others). A 10 ml pipette was used to verify the liquid medication measured by the participants. A pilot testing was conducted to evaluate the instrument. Fifteen volunteers participated in the measurement of the sample syrup and were asked to complete the preliminary survey with feedbacks. A majority of the participants said that the questions were clear and comprehensible and only the actual measurement of the sample syrup was considered time-taking.

Data Collection

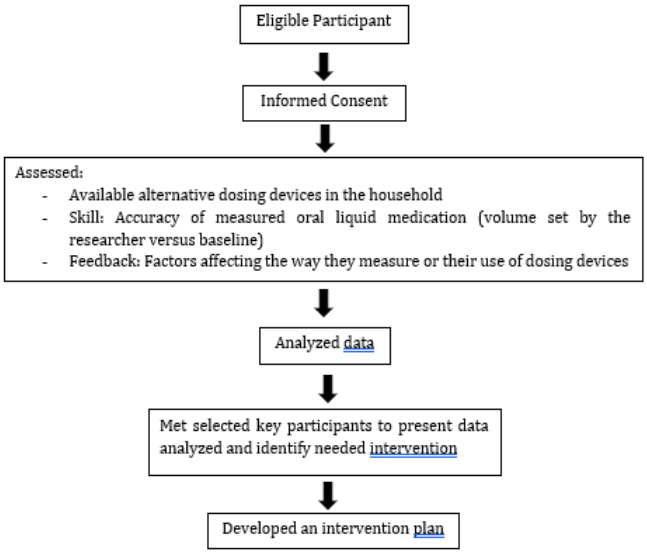

Figure 1. Diagrammatic presentation of data flow

The parents or guardians of children below 18 years old residing at a selected barangay in Pampanga were included in the study. An endorsement letter for conducting a house-to-house interview to identify target participants was used to ask permission from the barangay hall. Those who were willing to participate in the study specifically in measuring samples were asked to sign a written informed consent.

The participants were asked what available dosing devices they have at home and were requested to use any of these dosing devices (e.g., household teaspoon, household tablespoon, syringe, measuring cup, dropper or others) in measuring the liquid sample. The participants were instructed to measure 5 ml of liquid sample using their available dosing devices with two-minute rest in between measurements when there were two or more devices to be used. Rest was given to avoid possible factors that may affect their measuring ability like arm tension or hand numbness. The liquid sample used is a simple syrup (85% w/v sucrose solution, USP) prepared solely for research purpose. This is a representation of all the OTC oral liquid medications without any enclosed dosing device that are readily available and commonly dispensed in pharmacies. The volumes of the sample syrup are verified by

measuring the same samples with a 10 ml pipette to determine the margin of error. Liquid medication dosing error rates are classified as accurate dose, acceptable dose, overdose, and under dose. Accurate dose is defined as 5.0 ml, acceptable dose is 5.0 ± 0.5 ml (4.5 ml – 5.5 ml); overdose is more than 5.5 ml and under dose is with less than 4.5 ml (U.S. Pharmacopeia, 2008).

The participants were asked about the problems they encountered when measuring samples and the possible factors that affected the usage of alternative dosing devices. A structured interviewer-administered questionnaire was used for data gathering. All information was written on the questionnaire with the items required.

The researcher met the selected key participants on a scheduled date to present the analyzed data and identify the needed intervention. The key participants were expected to discuss the problems identified during the initial interview and bring out their personal knowledge about the problem to the researcher. An intervention was then constructed where the researcher brought theoretical and practical information relative to the change process although the participants were free to deviate from it. The researcher intervened only to clarify issues or introduce a new theme. The intervention was done after a thorough discussion, with the approval of the key participants.

Data Analysis

The collected data were encoded in Microsoft Excel where frequencies and percentages were gathered for descriptive purposes. Mean was determined for the measured dose of the liquid sample. Descriptive statistics was also used in analyzing data specifically the available dosing devices at the participants' households.

Ethical Considerations

An endorsement letter was handed to the office of the barangay captain of the chosen barangay in Pampanga. This is to ask permission to conduct a house to house interview to identify target participants. Upon approval, the potential participants were approached and asked by the researcher if they were willing to participate in the study. They were requested to read the informed consent form. For those who preferred not to read, the researcher read and discussed it to them for further clarifications. The study was conducted after securing an informed consent from the participants. Participants were briefed about the purpose of the study prior to data collection. All data were treated with confidentiality and were used for research purpose alone. After the analysis of data and results have been generated, the instruments used and all the information regarding the participants were discarded immediately through shredding. This study was subjected to the Holy Angel University Institutional Review Board (HAU-IRB) for approval and ethical clearance.

RESULTS

Table 1: Available Alternative Dosing Devices

Alternative Dosing Device	*f*	%
Measuring Cup	11	30.56
Syringe	7	19.44
Dropper	6	16.67
Household Tablespoon	6	16.67
Household Teaspoon	4	11.11
Others: Measuring spoon	2	5.56

(*n*=36)

Table 1 presents the available alternative dosing devices at the participants' households. The most available measuring device was the measuring cup with 30.56%, followed by syringe with 19.44%, dropper and household tablespoon with 16.67%, household teaspoon with 11.11%, and measuring spoon with 5.56%.

Table 2: Classification of Dosing Rate

	n	%	Mean
Overdose	15	41.67	
Acceptable dose	12	33.33	
Underdose	8	22.22	
Accurate Dose (5.0ml)	1	2.78	
Actual Measured Dose			5.07

(*n*=36)

Table 2 presents actual measurements of liquid medication by the participants. For the measured syrup, 41.67% of the participants measured doses were overdose, 33.33% measured an acceptable dose, 8% measured an underdose and only 1% measured accurate dose.

Table 3: Problems encountered during oral liquid medication measurement

Problems encountered	*f*	%
Illegibility of printed labels	13	30.95
Inability to understand units of measurement	5	11.90
Unable to comprehend instructions	2	4.76
Lack of knowledge about the proper dosing practices	3	7.14
Others:		
- *Matigas ang rubber ng dropper*		
- *Minsan may natatapon*		
- *Walang kasamang panukat yung gamot*		
- *Tantiyahan lang*	12	28.57
- *Pag may butal*		
- *Malabo ang mata*		
- *Maliit ang dropper*		
- *Pag may bula yung syrup*		
None	7	16.67

The participants were asked of the problems they encountered during the liquid medication measurement. Many respondents said it was difficult to measure because of the illegibility of printed labels on measuring devices; some underlying factors observed by the researcher include the continuous washing of the dosing device, such as a printed measuring cup, because they tend to use them multiple times. Some also stated other factors that could possibly affect the accuracy of their measurement such as the stiff rubber bulb of droppers and their small size, unavailability of dosing devices, required inexact volume of syrup (with decimal places), eye problems or eyesight defects and the presence of bubbles in the syrup.

Table 4: *Things Needed to Improve Participants' Measuring Abilities*

Things needed to improve measuring ability	*f*	%
Guidelines/detailed dosing instructions	26	50.98
Proper/standard dosing devices	25	49.02

The participants were asked on the things they need in order to improve their measuring abilities. Twenty-six (26) participants said that they need guidelines or detailed dosing instructions and 25 of them said they need a proper or standard dosing device.

DISCUSSION

The preference toward the use of measuring cup and syringe in measuring oral liquid medication is comparable to Sobhani, Christopherson, Ambrose, and Corelli (2008). In the cited study, participants (at least 18 years old above) were asked to measure a 5 ml dose of Tylenol (Acetaminophen) liquid medication using an oral syringe and a dosing cup provided by a manufacturer which was found to be the most commonly used device of the participants at home in measuring liquid medications. The results in the current study are relatively similar to Almazrou et al. (2015), in which 56% of the participants preferred using syringe while household spoon gave a result of 5%. Measuring cups are common in the participants' households since most of the available oral liquid medications in the drugstore are packaged together with the device. According to the participants, most of them also prefer

the use of syringes because of the recommendation of the physicians or pediatricians.

In Bayor et al. (2010), most (95%) of the participants used household spoon in measuring liquid medications and some (39%) would actually use spoon rather than the enclosed dosing device available with the liquid medication. The AAP Committee on drugs reported that 75% of patients would use a household teaspoon when administering liquid medication. In one study, participants who preferred teaspoon to measure 5 ml mentioned that their reason for selecting it is primarily convenience (Chamari, Perera, & Annalingam, 2015).

The overdose classification of the overall participants' actual measurements appeared to support Yin et al. (2014). The cited study posited that dosing errors were mostly observed from the parents who used measuring cups compared to dosing spoons, droppers or syringes. In an observational study it was found that the amount of a liquid medication when using household teaspoon was 62% inaccurate due to both over and under dosing (Muhammad et al., 2014). In Yin et al. (2014), the participants who used a household spoon had twice the odds of measuring an inaccurate dose. Ryu and Lee (2012) had similar findings and reported dosing spoons and cups were associated with relatively high rates of dosing error that exceeded 10% of the intended dose. In this study, it was observed that most participants do not understand the use of metric system in measuring the sample syrup because they are very much used to household system. Another practice of the participants in measuring is the improper use of measuring cup for they do not read the label very well and at eye level. Most of them believed that "5 ml is equivalent to one tablespoon" causing an overdosed measurement.

In Yin et al. (2010), the difficulty in measuring oral liquid medications due to the illegibility of printed labels was encountered by the participants. The said error is considered a major problem. Most of the evaluated dosing devices included in syrups' packaging contained missing or superfluous markings. This concern indicates that common OTC pediatric liquid medications frequently contained conflicting dosing instructions and imprinted labels on measuring devices. In the study, it was noticed that the participants were having difficulty in reading the embossed or printed labels on the devices they used like measuring cups, syringes and droppers. Some are due to eyesight defects or faded labels as a result of multiple usage.

Other factors mentioned by the participants that possibly affect the accuracy of their measurement are the stiff rubber bulb of droppers and their small size, unavailability of dosing devices, required inexact volume of syrup (with decimal places), eye problems or eyesight defects and the presence of bubbles in the syrup. In Hughes and Blegen (2008), most of the common types of errors resulting in patient death involved the wrong dose (40.9%), similar or misleading container labeling, performance or knowledge deficits, and inappropriate packaging or device design. On the other hand, it was suggested in Karch (2003) that faultiest measurements of the liquid medication were due to inability of parents to comprehend instructions, and some were noncompliant to the said regimen which can increase risk for mortality and morbidity.

The need of guidelines or detailed dosing instructions and a proper or standard dosing device to improve oral liquid medication measuring abilities were considered by the participants. This is relatively similar to the findings in Yin et al. (2014) in which proper and accurate use of measuring device and health literacy and counseling are some methods to reduce dose measurement errors and should be given of importance.

Table 5. Intervention Plan

I. Appropriate Dosing Devices used in measuring Oral Liquid Medications			
Objectives	**Topic outline**	**Teaching-learning activities/ strategies**	**Resources/ materials needed**
1. To increase the awareness of parents/guardians	1. Introduction of the following	- Visual aid presentati	Visual aid (Dosing Devices)

regarding the preferred and recommended dosing devices used in measuring oral liquid medications 2. To increase the awareness of parents/guardians on the harmful consequences of using household spoons in measuring oral liquid medications	appropriate dosing devices: 1.1. Measuring cup 1.2. Oral Syringe 1.3. Dropper 2. Harmful effects of administering inaccurate dose to pediatric patients	on - Discussion

Assessment Tool	Time Duration	Learning Outcomes
• Observation of participation and responses to questions during the presentation • Post-test	40 minutes	1. Increased awareness regarding the preferred and recommended dosing devices used in measuring oral liquid medications manifested through their ability to correctly identify the appropriate dosing devices used in dosing liquid medications correctly 2. Increased awareness of parents/guardians on the harmful consequences of using household spoons in measuring oral liquid medications

II. Measurement Conversion

Objectives	Topic outline	Teaching-learning activities/ strategies	Resources/ materials needed
1. To enhance the level of knowledge of parents/guardians regarding the appropriate unit of measurement used in dosing liquid medications 1.1. To identify the appropriate unit of measurement used in dosing liquid medications 1.2. To determine the conversion of commonly used household measurement units into metric system	Conversion of the following: 1. Teaspoon to Milliliters 2. Teaspoon to Tablespoon 3. Tablespoon to Milliliters	- Lecture	Syrup packaging box with dosing instruction label, Paper, Ball pen, White board/Black board, Marker/Chalk

Assessment Tool	Time Duration	Learning Outcomes
• Post-test	40 minutes	1. Enhancement of the level of knowledge on appropriate unit of measurement used in dosing liquid medications evident through their ability to: 1.1. Correctly identify the appropriate unit of measurement used in dosing liquid medications 1.2. Correctly demonstrate conversion of commonly used household measurement units into metric system

III. Proper Usage of Appropriate Dosing Devices in measuring Oral

Liquid Medications			
Objectives	**Topic outline**	**Teaching-learning activities/ strategies**	**Resources/ materials needed**
To enhance the level of knowledge of parents/guardians regarding the proper usage of appropriate dosing devices in measuring oral liquid medications	Proper usage of the following dosing devices: 1. Measuring cup 2. Oral Syringe 3. Dropper	- Visual aid presentation - Demonstration	Visual aid (Dosing Devices), Simple Syrup
Assessment Tool	**Time Duration**	**Learning Outcomes**	
Return Demonstration	50 minutes	Enhancement of the level of knowledge regarding the proper usage of appropriate dosing devices in measuring oral liquid medications evident through their ability to demonstrate the proper usage of dosing devices	
IV. Additional Instructions on Liquid Medication Safety			
Objectives	**Topic outline**	**Teaching-learning activities/ strategies**	**Resources/ materials needed**
To increase the awareness of parents/guardians regarding the safety instructions and good hygiene practices in oral liquid medication	1.Contamination Prevention 2. Dosing Accuracy	- Demonstration	Visual aid (Dosing Devices), Simple Syrup
Assessment Tool	**Time Duration**	**Learning Outcomes**	
Return Demonstration	40 minutes	Increased awareness regarding the additional instructions on liquid medication safety manifested through their ability to determine safety instructions and perform good hygiene practices in oral liquid medication	

Table 5 shows the proposed intervention plan based on the participants' responses, which tends to support the aim of the study to improve the parents or guardians' oral liquid medication dosing abilities. This is a researcher-developed seminar content which includes teaching-learning activities on each selected topic with an estimated overall duration of three (3) hours. This proposed intervention plan is designed to be implemented in a local community or in a barangay level seminar.

The intervention plan consists of teaching-learning activities on the introduction of appropriate dosing devices in measuring oral liquid medications such as measuring cup, oral syringe and dropper. It also includes a discussion on the harmful effects of administering inaccurate dose to pediatric patients caused by the use of inappropriate dosing devices such as household tablespoons and household teaspoons. Although majority of the participants used the proper dosing devices, some also used household spoons in measuring syrups.

In response to the AAP and the US-FDA's huge desire to promote dosing accuracy, parents must use dosing tools with standard markings (e.g., oral syringes, droppers, dosing cups) rather than nonstandard kitchen spoons, which vary widely in size and shape. In Yin et al. (2016), oral syringes are considered the gold standard when accuracy is crucial. In Wansink and van Ittersum (2010), it was mentioned that the use of kitchen tablespoon and teaspoon is encouraging for the parents because many liquid medications, especially OTC

drugs, and some doctors would base their medication dosage in teaspoon and tablespoon which can lead to dosing error.

The intervention plan also contains teaching-learning activities on units of measurement conversions to help the participants identify the appropriate unit of measurement used in dosing liquid medications. Another is to determine the conversion of commonly used household measurement units into metric system since one of the problems encountered by the participants in measuring the syrup was the inability to understand units of measurement because they are very much used to using household system. It was observed in the data collection that most of the participants believed that "5 ml is equivalent to one tablespoon" leading to overdosing in measurement.

The third part of the intervention plan includes the demonstration of proper usage of the appropriate dosing devices in measuring oral liquid medications. This demonstration is in response to the participants' knowledge deficiency about the proper dosing practices. This part will also specifically involve instructions on how to measure required inexact volumes (or volumes prescribed in decimal places). This difficulty was evident because of the improper use of measuring cup. Participants did not read the label at eye level during the actual collection of data, which also affected their dosing accuracy results.

The last part of the intervention plan covers the supply of additional instructions on liquid medication safety to teach the parents and guardians some safety instructions and good hygiene practices to address the parents/guardians' lack of knowledge on proper dosing practices. This part is to prevent contamination of oral liquid medication which might also be the reason behind the presence of bubbles in the syrup which affect the participants' accuracy of dose measurement. The third and last part of the intervention plan aims to address the need of guidelines or detailed dosing instructions and of a proper or standard dosing device to improve the oral liquid medication measuring abilities of the participants.

CONCLUSION

The study revealed that most of the participants who are parents and guardians of children aged 18 years below from a selected barangay in Guagua, Pampanga preferred the use of measuring cup in measuring oral liquid medication. The actual measurements of the sample syrup by the participants using the available alternative dosing devices in their household were predominantly overdosed.

The illegibility of printed labels on measuring devices was the most frequently encountered problem by participants during the liquid medication measurement. One of the underlying factors observed by the researcher in this case is the continuous washing of the dosing device, such as a printed measuring cup, because they tend to use them more than once before purchasing another to save money. Some other factors that possibly affected the accuracy of their measurement include the stiffness of the rubber bulb in droppers and their small size, unavailability of dosing devices, required inexact volume of syrup (with decimal places), eye problems or eyesight defects and the presence of bubbles in the syrup. Based on their own perception, participants need guidelines or detailed dosing instructions and a proper or standard dosing device to improve their measuring abilities.

The researcher proposed an intervention plan which supports the aim of the study to improve the parents or guardians' oral liquid medication dosing abilities upon learning the problems encountered and the things needed by the participants. The proposed intervention plan was developed after thorough discussion with and the approval of key participants. The plan is composed of teaching-learning activities on the introduction of appropriate dosing devices, units of measurement conversions, and demonstration of the proper usage of appropriate dosing devices in measuring oral liquid medications and additional instructions on liquid medication safety.

Implications of the study

The success of this research will benefit mainly the pediatric patients as basis of a future comprehensive pediatric dosing strategy to reduce liquid medication dosing errors.

This study helped determine what dosing device is commonly used by parents or guardians of pediatric patients. This step can assess the rate of medication dose errors in administering oral liquid medication to the pediatric patients with the use of various alternative dosing devices. This study may inform parents and the community in the barangay level that administration of a dose that is either greater or lesser than the amount intended may have a negative effect especially on a pediatric patient and educate the local community on the proper way of measuring oral liquid medications using the proper dosing devices through an active community engagement in interrelated barangay activities or seminars.

The ideas presented in the study may be used as a reference in conducting new studies for future researchers. This may also serve as a cross-reference that may give an overview of the current situation on oral liquid medication dose errors.

Recommendation and directions for future research

In this study, an intervention plan was developed and proposed after the analysis and discussion of the several problems identified in measuring oral liquid medication and the things needed by the participants to improve their measuring abilities. The next endeavor is to complete the final phase in action research cycle which is *Reflecting,* where the implementation of the intervention plan takes place (Hinchey as cited in Streubert & Carpenter, 2011). This phase also includes revisiting of study participants to evaluate its impact that may bring out a lasting change in the community practices.

Consideration of Study Limitations in Future Research

To future researcher who may wish to replicate the study or to conduct a related research, it is recommended that s/he does partial or complete replication of the study in other setting. S/He may consider increasing the target population and incorporating additional socio-demographic profile of the participants to be a basis in explaining factors and other related phenomena that may emerge during the measurement of oral liquid medication. S/He may include other factors that could possibly affect the measuring ability that were not covered by the intervention plan such as stiff rubber bulb of droppers and their small size, unavailability of dosing devices, eye problems or eyesight defects, illiteracy, reason for choosing the preferred measuring device, knowledge on proper measurement of liquid preparations, and viscosity of the sample liquid medication.

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