Medication administration challenges among children and young people aged 0 to 18 years old

(A mixed method approach)

Doctor of Philosophy

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April 2021

Thesis Summary

Medication errors frequently occur with paediatric patients who take long term medication at home, where parents/caregivers are responsible for administering the medication. The issues and the extent to which they can affect medication safety and accuracy in the UK have not been formally established. Therefore, this thesis aimed to investigate medication administration problems, issues and challenges occurring at home among children and young people aged 0 to 18 years old, where parents and patients were responsible for administering their medication.

A systematic review of medication administration problems for paediatrics caused by parents/caregivers, including the role of health literacy, found that there is little literature other than that published in the USA that has examined medication administration problems using a validated health literacy tool.

From the survey conducted among paediatric pharmacists regarding this issue, the respondents indicated that the consultation time between the patient and the pharmacist is critical to reducing medication administration problems. Furthermore, a few suggested there is a need for further training and educational material for parents and young people to improve understanding in regards to medication use at home.

Forty-nine parents and young people were interviewed from five sites in England. The participants suggested a few recommendations that could help them administer or take medication safely at home; this includes a visual demonstration of the dose to be administered. Finally, 40 participants were recruited in the observational session, where it was found that dose accuracy for both liquids varied across each dose volumes. And there was a significant association of dose accuracy with measurement tool size, type and dose volume.

This work provides evidence that the parents/carer of children and young people require assistance to ensure safe medication administration at home. Future work is needed to develop a complex intervention to address the issues.

Keywords: Medication errors, paediatrics, young people, parents, informal caregivers, health literacy

Acknowledgements

I wish to acknowledge the support and direction provided by my supervisor Dr Chi Huynh, and by my associate supervisors Dr David Terry and Dr Daniel Kirby. Thank you for all the time that you have dedicated to my PhD since it commenced in October 2017. I am forever grateful for the exceptional support, guidance and knowledge that I have gained from you all.

I would like to thank Aston University and the Aston Pharmacy School, I was so lucky to work in an enabling environment with strong models. Also I would like to thank all the local collaborators who helped me conduct the REMEDY study Stephen Tomlin, Catrin Barker, Louise Bracken, Nana Christiansen, Dr Jeff Aston and Joanna Correa-West.

I would also like to thank my PhD colleagues at Aston Pharmacy School, especially Zakia Shariff for her help with the literature review.

I would like to thank my entire family mom, dad, Ahmed and Khalid for being supportive all the way. And a special thank you for my beloved husband Sami and beautiful daughter Sophia and Son Rakan, I am grateful for your patience and support during this challenging time in my life. I look forward to spending more time with all of you!

I would also like to give thanks to all participants who, without their willingness to take part, this research would not have taken place.

Publications

- Published Protocol:

- Dania Dahmash, Zakia Ramjee, Daniel Kirby, David Terry, Chi Huynh. Medicine use and optimisation for paediatric patients – medication administration and adherence of parents. PROSPERO 2018 CRD42018091590 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018091590

Published abstracts in a Peer reviewed journal

- Dahmash D, Ramjee Z, Kirby D, et al. P002 Medicine use and optimisation for children and young adults aged 0–18 years old – medication administration and adherence of parent/caregiver and child Archives of Disease in Childhood 2019;104:e2.
- Dahmash D, Huynh C, Kirby D, et al. P09 A survey of the NPPG group concerning medication administration problems among children and young people aged 0 to 18 years old. Archives of Disease in Childhood 2020;105:e10-e11.

- Accepted and under review papers

  - Dahmash DT, Shariff ZB, Kirby DJ, et al. Literature review of medication administration problems in paediatrics by parent/caregiver and the role of health literacy. BMJ Paediatrics Open 2020;4:e000841. doi: 10.1136/bmjpo-2020-000841. **(Published on 26/11/2020).**
  - NPPG survey titled "Paediatric Medication Administration at Home - the pharmacist's perspective" submitted to International Journal of Pharmacy Practice**. (Currently under the second round of review)**.

- Accepted posters in conferences

  - Dania Dahmash*, Zakia Ramjee, Dr Daniel Kirby, Dr David Terry, Dr Chi Huynh. Administering Medicines to Children: What are the Issues? **(Presented during the research day at Aston University in 2018).**
  - Dania Dahmash, Zakia Shariff, Dr Daniel Kirby, Dr David Terry, Dr Chi Huynh. Medicine Use and Optimisation for Children and Young Adults Aged 0-18 Years Old – Medication

Administration and Adherence of Parent/Caregiver and Child. **(Presented during the annual NPPG conference in 2018)**.

- Dania Dahmash, Zakia Shariff, Dr Daniel Kirby, Dr David Terry, Dr Chi Huynh. Medicine administration accuracy in paediatric patients – a systematic review. **(Presented in the APS conference in 2018)**.
- Dania Dahmash, Dr Chi Huynh, Dr Daniel Kirby, Dr David Terry. A survey of the NPPG group concerning medication administration problems among children and young people aged 0 to 18 years old. **(Presented during the annual NPPG conference in 2019).**
- Dania Dahmash, Dr Chi Huynh, Dr Daniel Kirby, Dr David Terry An Insight into Medication Administration Challenges among Children – A Pharmacy Team Perspective. **(Presented in the APS conference in 2019).**
- Dania Dahmash*, Chi Huynh, Daniel Kirby, David Terry. Pharmacy Professionals Identify the Importance of Counselling to Reduce Paediatric Medication Errors. **(Presented in the FIP Abu Dhabi in 2019).**
- Dania Dahmash, Daniel J Kirby, David Terry, Jeff Aston , Joanna Correa West ,Chi Huynh. Realising the issues of medicine administration to the young (REMEDY). **(Presented in the FIP Abu Dhabi in 2019).**

Table of Content

List of Tables

List of Figures

List of Abbreviations

BASE	Bielefeld Academic Search Engine
BPCA	Best Pharmaceuticals for Children Act
CASP	Critical Appraisal Skills Programme
EThOS	E-thesis Online Service
FDA	Food and Drug Administration
GCP	Good Clinical Practice
HLS-EU	European Health Literacy Survey
LEP	Limited English Proficiency
MHRA	Medicines & Healthcare products Regulatory Agency
NHS	National Health System
NPPG	Neonatal and Paediatric Pharmacists Group
NPSA	National Patient Safety Agency
NVS	Newest Vital Sign
OTC	Over-the-Counter
PI	Principle Investigator
PILs	Patient Information Leaflets
PIS	Participant Information Sheets
PROSPERO	International Prospective Register of Systematic Reviews
REMEDY	Realising the Medicine administration issues to the young
SDM	Shared Decision Making
UK	United Kingdom
WHO	World Health Organisation

Chapter 1 - Introduction and overall aim and objective of the project

1.1 Introduction

When it comes to children, medication related errors are amongst the most common medical errors, and medication administration errors in particular accounts for 72% to 75% of the overall errors made in paediatrics (Miller et al., 2007).

Medication administration errors may have a direct impact on patients' safety in relation to morbidity, mortality and adverse events. Several definitions of medication administration errors were reported in the literature, and are summarised in ***Table 1.1*** (Ghaleb et al., 2006). Literature and research regarding medication administration errors have paid a lot of attention to medication administration errors occurring within healthcare facilities (inpatient settings). However, there is not enough data in regards to medication administration errors occurring at home. While issues have been addressed across other countries such as in the USA (studies listed in chapter 2 in the systematic review included studies), this has not been investigated in the United Kingdom (UK).

Other than the clinical impact of medication problems, there is a financial burden on healthcare systems associated with medication errors. Worldwide, medication errors are estimated to cost healthcare systems more than 42 billion US dollars. In the UK alone, over one billion prescription items are dispensed annually, costing the National Health Service (NHS) over 16 billion pounds. More than 230 million medication errors are reported yearly in the UK, with an average of 712 deaths linked to preventable adverse drug reactions (Department of Health and Social Care, 2018). Owing to the increased rates of medication errors across the globe, the third Global Patient Safety Challenge, launched by the World Health Organisation (WHO) in 2017 was themed "medication safety". This initiative was aimed at reducing medication errors and preventable medication-related harm by strengthening the healthcare systems globally and triggering action in these areas. The WHO encouraged different key stakeholders and countries to adapt and work on the important key priorities in the upcoming five years, in order to reduce global preventable medication errors by 50% (WHO, 2016). Overall, initiating a programme to reduce medication-related errors will have a direct positive impact on both patient health and the global economy.

In line with the WHO recommendations, The Department of Health and Social Life in England took an initiative by publishing a report in February 2018, titled "Short Life Working Group on reducing medication-related harm". The report recommended a programme for reducing medication harm. The following include some of the priority steps suggested in the report to reduce medication errors in paediatrics (Department of Health and Social Care, 2018).

1- Improve shared decision making so that patients and carers are encouraged to ask questions about their medications; and health care professionals actively support patients and carers in making decisions jointly, including when to stop medication.

2- Encourage and support patients and families to raise any concerns about their medication.

3- Professional regulators and professional leadership bodies should also encourage reporting and learning from medication errors.

4- Work with industry to produce more patient-friendly packaging and labelling.

5- Work with pharmacy dispensing computer system suppliers to ensure that labelling contributes to safer use of medicines and does not hinder; for example, by labels being stuck over packaging or by using unfamiliar language.

6- New research on medication errors should be encouraged and directed down the best avenue to facilitate positive change.

There are limited research studies looking at medication administration errors occurring at home. Children rely primarily on their parents or caregivers to administer and manage their medication at home while older children, (young people) may be responsible for their own medication administration in partnership with their parent/carer or independently when they reach capacity.

Table 1. 1: Definitions of medication administration error

Definitions of Administration Error
A medication error was defined as: omitted dose, wrong dose, extra dose, unordered medication, wrong route, wrong time, expired medication, allergic to medication, and other (O'Brodovich and Rappaport, 1991).
Errors were considered to be any deviation from accepted drug administration procedures at the hospital (Rosati and Nahata, 1983) (Nahata, 1988)

The American Society of Hospital Pharmacy defined Medication Error (ME) as a dose of medication that deviates from physician's order as written in the patient chart or from standard hospital policy and procedures Except error of omission, the medication dose must actually reach the patient. Prescribing errors are excluded from this definition. The 9 categories of MEs are:

1. omission error;
2. unauthorised drug error;
3. wrong dose error;
4. wrong route error;
5. wrong rate error;
6. wrong dosage form error;
7. wrong time error;
8. wrong preparation of the a dose;
9. incorrect administration technique (Raju et al., 1989;Tisdale, 1986;Schneider et al., 1998).

Medication Errors were grouped into four categories according to set error type definitions; these are dose; I.V. compatibility; drug interaction; and administration (Bordun and Butt, 1992).

Medication Administration error is any deviation between prescribed and actually administered drugs (Fontan et al., 2003).

1.2 Paediatrics are a challenging age group- why?

Paediatric patients cannot be simply considered as a small version of adult patients. Among paediatrics, variations exist in their physiology and in their medical conditions. There are different stages of paediatric development; each stage is defined differently in the literature. In England, most healthcare professionals in specific pharmacists and pharmacy-related staff refer to the BNF for Children when a child`s medication is being prescribed and dispensed; hence, the age definition used in this chapter was adopted from the British National Formulary for Children ***(Table 1.2)*** (BNFc, 2018).

Table 1. 2: Classification of Paediatrics by age groups according to the BNF (adopted from (BNFc, 2018))

Category	**Age Range**
Preterm neonate	< 37 weeks gestation
Term neonate	37 to 42 weeks gestation
Post-term neonate	≥42 weeks gestation
Neonate	From 0 - 28 days of age (or first 4 weeks of life)
Infant	From 28 days - 24 months of age
Child	From 2 years - 12 years of age
Adolescent	From 12 years - 18 years of age

In general, within the paediatric population there are substantial physiological differences within each age group. This developmental process of growth and maturation is one of the discrepancies that distinguishes the paediatric population from the adult population; where each age spectrum has a unique pharmacological response. Therefore, when it comes to medication use, children should not be treated as mini adults (English, 1989).

Currently, due to a lack of paediatric formulations, healthcare professionals have to prescribe medications to children which are intended for adults (World Health Organization, 2007). Those medications often have no published data regarding their bioavailability, efficacy and toxicity. Additionally, any innovative paediatric medications have limited or no data concerning their long-term benefits and risks (WHO, 2007). Finally, the different cultural and educational backgrounds of

the child's parents and caregivers can lead to misunderstanding and misinterpreting of medication use and instructions, especially of patient information leaflets and promotion packages (World Health Organization, 2007).

Before 2002, there was no data about medication safety and adverse events occurring in children from using unlicensed drugs. However, in 2002 the Best Pharmaceuticals for Children Act (BPCA) was introduced by the FDA and became law. This law was further re-authorised in 2007 and 2012 under the Food and Drug Administration (FDA) Amendments Act and the (FDA) Safety and Innovation Act, consecutively in the USA (NIH, 2002). The act provides a mechanism for the National Institute of Health (NIH) to review off-label medication safety profiles exclusively in children (World Health Organization, 2007). Both the NIH and the USA (FDA) have worked together to ensure that findings from the studies were considered. Since then, 65 products have been reviewed and new labelling warnings or further studies were articulated for some of the products (World Health Organization, 2007).

In January 2007, the Paediatric regulation came into force in the European Union, including in England (The European Parliament and the Council of the European Union, 2006). It aimed at enhancing medication safety in children; encouraging the pharmaceutical industries and national competent authorities to develop medications for children based on specific paediatric experiences, and also to conduct pharmacovigilance for medicines used among paediatric populations (World Health Organization, 2007).

Despite the current paradigm shift towards urging pharmaceutical manufacturers to develop a paediatric-specific dosage form, the change is still in its infancy and unlicensed paediatric medication are still in use. This is expected to further contribute to medication errors in paediatrics (Chin and Joos, 2016).

1.3 Incidence rates of medication administration problems outside a clinical setting- what has been reported?

Medication errors occur frequently in paediatric outpatient clinics, commonly at the medication administration stage (Kaushal et al., 2007). Incidences of medication errors among children and young people can be prevented or reduced (Kaushal et al., 2007). Studies have indicated that improved communication between different healthcare professionals and parents could lead to a reduction of medication harm for a children (Neuspiel and Taylor, 2013). Furthermore, improving dosage instructions on the medication labels provided to parents and caregivers could lead to a decrease in medication errors. (Brass et al., 2018).

In the USA, a multisite study was conducted aiming at identifying types of medical errors occurring in ambulatory paediatric clinics. The study identified 136 medical errors; 56 (38%) were medical treatment errors, among which 47 (84%) were related to medications (Slora et al., 2005). The following cases were documented as administration errors originating from miscommunication:

1- "Parent left message for refill of Adderall 15 mg, 1QDS. Upon further questioning, it was learned that patient was actually taking 1/2 pill in morning and 1/2 pill at lunch."

2- "Mother given written instructions for psychotropic med — Adderall. Told to give 1/2 tab BID and interpreted it as bedtime."

3- "Pediatric neurologist wanted to change the patient from liquid to capsule form of anticonvulsant. Mom misunderstood the directions and gave both meds for a week. Child developed blurred vision, stuttering and ataxia."

In 2007, another USA based prospective cohort study involving 1788 paediatric patients was conducted in six different paediatric outpatient clinics. The study aimed at measuring the rate and the type of adverse drug events. In total, 283 errors were identified accounting for 16% of children treated in the selected sites; 57 (3%) adverse drug events were preventable, among which 40 (70%) reported events were related to parental administration error (Kaushal et al., 2007).

In South Korea, a cross-sectional study was conducted on prescribed parents` administration of medication to their children at home (You et al., 2015). The study identified that parent's use the information sheet as a source of medication administration for their children, and the majority of parents use cups (43.6%) for children`s liquid medication administration. Furthermore, 85.5% of the parents reported that they had stopped administering the medication to their children when their children stopped showing symptoms; and 13.4% would give a medication to another child for whom it had not been prescribed. Finally, when participants were asked if they needed an education programme on the administration of medication, 96.1% said yes.

Furthermore, a USA study highlighted that some children and young people are diagnosed with chronic illnesses; those illnesses need to be managed by multiple complex medication regimens. These children will require their parents` support for medication administration and dose preparation. Hence, there is an increased risk of medication errors (Walsh et al., 2011a). A complex regime is considered when two or more medications are prescribed; complex medication administration process (such as crushing a tablet before administration); complex dose volumes that includes decimals and multiple medications administered at different times that needs to be administered in an outpatient setting (home) while parents or young people are involved in the process of administration (Walsh et al., 2011a).

Several studies have discussed medication-related incidences among children occurring at home. In an observational study carried out over six months, 52 homes were visited, and 280 prescriptions were reviewed. A total of 61 medication errors were identified, among which 31 errors could potentially cause injuries and nine errors did actually cause an injury to the child (Walsh et al., 2011b). Communication barriers were reported as the main reason behind those errors. In some cases there was even miscommunication between the two parents; this resulted in medication administration errors in 25 (15%) cases. Furthermore, the study highlighted that medication errors were significantly reduced by 51% in children whose parents used a supporting tool to optimise medication use at home. The following are some reported quoted examples from the study (Walsh et al., 2011b), to demonstrate the importance of communication and the crucial impact of it on a child`s health:

1- "Parents were told to increase dose of antiepileptic medicine due to frequent seizures. Parents do not understand and do not increase dose. Seizures continue."

2- "Child with vitamin D deficiency. Mom gives less than half of the appropriate dose. Persistent vitamin D deficiency despite treatment prompts further laboratory testing by doctors."

Another USA based study investigated the type of medication errors encountered among children younger than 18 years old diagnosed with depression. The study reported 451 medication errors, of these, 95% reached the patient. Most of the errors (33%) were identified at the medication administration point, 30% at the dispensing stage and 7.9% at the prescribing phase (Rinke et al., 2010).

In conclusion, improved communication between healthcare-professionals including practitioners, nurses, and pharmacists is important to reduce incidence rates related to medication errors. In addition, improved communication between healthcare professionals and parents can dramatically reduce preventable medication errors. As all data was from outside of the UK, this led to further investigate this issue with health care professionals members of the Neonatal and Paediatric Pharmacists Group (NPPG), seeking their opinions and experience, as well their recommendations about medication administration issues among children and young people. Children rely on their parents for medication administration, and since most studies reported that miscommunications between healthcare professionals and parents or caregivers is the main reason behind medication errors among children in a home setting, this rationalises further investigation into the main issues and barriers reported in the literature. As such, the systematic review described in this research aims at addressing all issues that hinder medication optimisation and dose accuracy in children and young adults aged 0-18 years old; investigating the role and evaluating the health literacy of parents or caregivers, including and its impact on their children`s medication use.

Medication administration problems could be associated with different causality factors that have been closely identified during the systematic review investigation presented in **Chapter 2**. These causality factors could be due to the sociodemographic characteristics of the parents as well as the

patients themselves. Among the commonly identified causality factors in the literature were health literacy levels.

1.4 What is health literacy?

In the late 19th century, the word 'literacy' originated from the word 'literate'. This term was generally used to describe the ability of a person to read and write; however, now in addition to that it refers to a person's capability to maintain knowledge in a particular topic (English Oxford Dictionaries, 2018 ;Peerson and Saunders, 2009).

The term 'Health Literacy' was first introduced in the early 1970s, due to the increased interest in public health and well-being (Peerson and Saunders, 2009;Sørensen et al., 2012). During the 90s the concept emerged further and caught researchers' attention. Hence, various definitions of health literacy evolved; each author defined health literacy from a different perspective, as summarised in ***Table 1.3***.

1.5 Health literacy and administration errors- the association between medication administration problems and health literacy

As demonstrated above, medication errors among children and young adults are mainly due to administration errors. Errors due to inaccurate dosing by parents or caregivers account for 50% of all medication errors in children (Yin et al., 2008). Different standardised measurement tools exist in the market such as droppers, dosing cups, oral syringes and dosing spoons. Those tools are available to support parents in measuring the child's dose. Yin and his colleagues (2010a) have studied dosing errors associated with parents' inadequate health literacy. The study enrolled 302 English or Spanish speaking parents or caregivers from various socio-economic backgrounds. Parents` and caregivers` health literacy was assessed using the Newest Vital Sign test. The participants were further subdivided into three groups according to their health literacy level: limited literacy, possible limited literacy and adequate literacy. The study showed that low levels of health literacy are associated with dosing errors; parents with limited health literacy performed more dosing errors compared to parents

with adequate literacy (161 vs 22 errors respectively). Further work addressing ways to optimise dose accuracy by parents is needed (Yin et al., 2010).

Further investigations into the association of low heath literacy of parents and weight-based dosing, and into the use of non-standardised measuring tools, such as kitchen tablespoons and teaspoons, were carried out (Yin et al., 2007),. These non-standardised measuring tools are used by a high proportion of parents (20-73%), despite not being recommended by the American Academy of Pediatrics (AAP) (Rheinstein, 1994; McMahon et al., 1997,). The study evaluated 292 parents. Overall, parents with inadequate and marginal health literacy levels, in comparison to parents with adequate health literacy, were associated with both a lack of knowledge regarding weight-based dosing (85.3% vs 61.2%) and the high use of non-standardised measuring tools (34.7% vs 19.2%). The study recommended that further intervention is needed to reduce medication administration errors among parents and caregivers from different socio-economic backgrounds.

Another study assessed parents' and caregivers' understanding of the age indicated on over-the-counter (OTC) cold and flu medications` labels (Lokker et al., 2009). Results from this study revealed that low levels of parental health literacy increase the risk of misinterpretation of OTC products indicated to children, and are further influenced by the language, pictures and labels used on the product, resulting in medication errors, in particular administration and dosing errors (Lokker et al., 2009).

Table 1. 3: Health Literacy various definitions: all definitions are quoted as per the original paper and order by year of publication (Sørensen et al., 2012)

Definition of "Health Literacy"	**Organisation**
1- Cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.	(WHO, 1998)
2- The constellation of skills, including the ability to perform basic reading and numeral tasks required to function in the healthcare environment	(Parker et al., 1999)
3- Health literacy means more than being able to read pamphlets and successfully make appointments. By improving people's access to health information and their capacity to use it effectively, health literacy is critical to empowerment.	(Nutbeam, 2000)
4- The individuals' capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions.	(Nielsen-Bohlman et al., 2004)
5- As the evolving skills and competencies needed to find, comprehend, evaluate, and use health information and concepts to make educated choices, reduce health risks, and improve quality of life	(Nielsen-Bohlman et al., 2004)
6- The ability to make sound health decision(s) in the context of everyday life--at home, in the community, at the workplace, the healthcare system, the market place and the political arena. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility.	(Kickbusch et al., 2006)
7- The wide range of skills, and competencies that people develop to seek out, comprehend, evaluate and use health information and concepts to make informed choices, reduce health risks ad increase quality of life.	(Zarcadoolas et al., 2009;Zarcadoolas et al., 2003;Zarcadoolas et al., 2005)
8- Individual's possession of requisite skills for making health-related decisions.	(Paasche-Orlow and Wolf, 2007).
9- The ability to read, filter and understand health information in order to form sound judgements.	(European Commission, 2007)
10- Placing one's own health and that of one's family and community into context, understanding which factors are influencing it, and knowing how to address them	(McQueen et al., 2007).
11- The capacity to obtain, interpret and understand basic health information and services and the competence to use such information to enhance health	(Sørensen et al., 2012)

Definition of "Health Literacy"	**Organisation**
12- The ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course	(Rootman and Gordon-El-Bihbety, 2008)
13- The knowledge, skills and abilities that pertain to interactions with the healthcare system	(Ishikawa and Yano, 2008)
14- Is a process that evolves over one's lifetime and encompasses the attributes of capacity, comprehension, and communication. The attributes of health literacy are integrated within and preceded by the skills, strategies, and abilities embedded within the competencies needed to attain health literacy.	(Mancuso, 2008)
15- The knowledge and skills required to understand and use information relating to health issues such as drugs and alcohol, disease prevention and treatment, safety and accident prevention, first aid, emergencies, and staying healthy	(Australian Bureau of Statistics, 2008)
16- The degree to which individuals have the capacity to read and comprehend health-related print material, identify and interpret information presented in graphical format (charts, graphs and tables), and perform arithmetic operations in order to make appropriate health and care decisions.	(Yost et al., 2009)
17- The ability to understand and interpret the meaning of health information in written, spoken, or digital form and how this motivates people to embrace or disregard actions relating to health.	(Stocks et al., 2009).
18- Ability to derive meaning from different forms of communication by using a variety of skills to accomplish health-related objectives"	(ROSS ADKINS and Corus, 2009)
19- The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions	(Freedman et al., 2009)
20- People's ability to obtain, process, communicate, and understand basic health information and services	(Koh et al., 2013)

1.6 Aims and objectives

The majority of medication administration studies were conducted on parents and caregivers based in the USA, and few were conducted outside the USA. In addition, to my knowledge, there are limited data available regarding the involvement of UK parents and caregivers which addresses the main issues: the challenges of medication administration among children at home. Hence, this research project aims at further exploring and reporting all published data by conducting an extensive systematic review, accompanied by an online survey targeting healthcare professionals, specifically pharmacists and pharmacy-related staff. This is followed by interviews targeting parents and young people, in addition to an observational session to assess parents` and young people`s dose accuracy with liquid medication. Findings from the review, the survey and the interview will ultimately help establish recommendations for an intervention to reduce medication administration errors for children and young people.

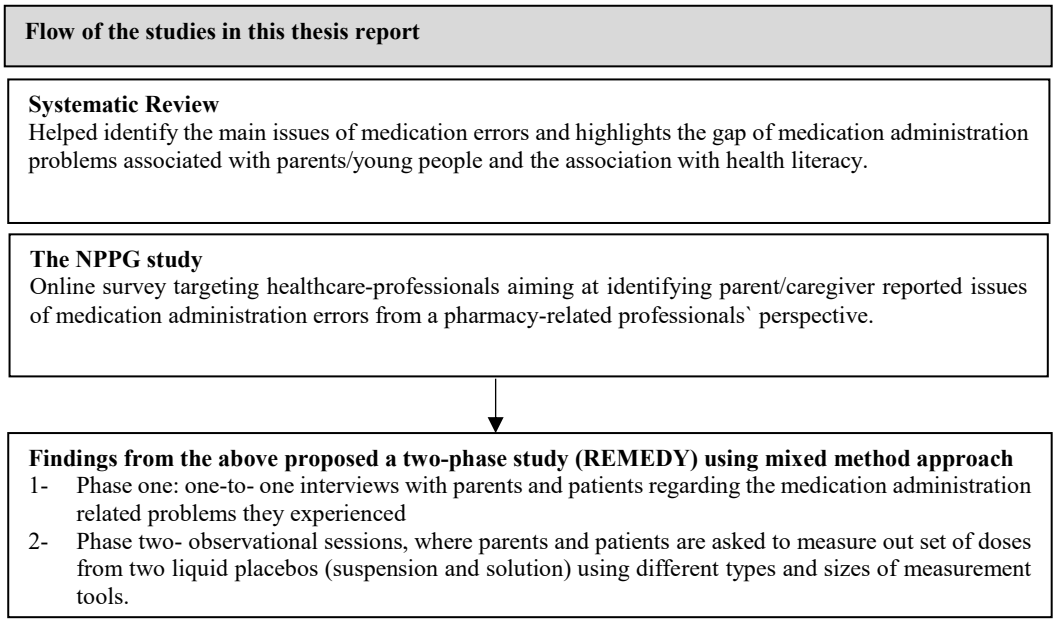

Figure 1. 1: A summary figure of the conducted studies to address the research project question

1.7 Overall thesis outline

1.7.1 Chapter 2: Systematic Review

This systematic review aims at identifying current medication administration challenges in the light of the health literacy of the parent/carers. The review includes studies that assessed participants` health literacy levels and their association with medication administration problems.

1.7.2 Chapter 3: NPPG Survey-pharmacists` perspective on medication administration problems at home for children and young people

When it comes to medication use management among children, healthcare professionals and in particular pharmacists, are directly involved with the child`s parents; this integrated engagement between pharmacists and carers is much needed to ensure optimised use of prescribed medications. Hence, an online survey was proposed to further elaborate on this issue from a healthcare professional`s perspective. The survey targets members of the Neonatal and Paediatric Pharmacists Group (NPPG) and the questionnaire is designed to understand their experiences and ask for their recommendations about this issue.

1.7.3 Chapter 4: Realising the issue of medicine administration to the young (REMEDY): Phase One-semi- structured interviews

The systematic review, as well as the survey, resulted in showing a gap in the literature in regards to medication administration problems among children at home in the UK, from parents` and young people`s perspectives. There was no study conducted in the UK to address this issue, and in order to do so a one-to-one interview with the parents /informal caregiver and patients was proposed as the ideal to shed the light on medication administration problems at home. This helped us to identify if there are medication administration issues and challenges among children in the UK, and what is the nature of these problems.

1.7.4 Chapter 5: Realising the issue of medicine administration to the young (REMEDY): Phase Two- observational session

A similar research approach was conducted at an international level to address dose accuracy and its association with measurement tool size and type, as well as health literacy levels. This quantitative yet qualitative study addressed some problems that were not picked up during the interviews.

1.7.5 Chapter 6: Conclusion and future recommendations

This chapter provides an overall aim of each project and its key findings.

The findings of each project lead to supplementary research projects that could further enrich our understanding of medication administration problems among children at home.

Chapter 2 - Systematic Review

A Literature review of medication administration problems in paediatrics by parent/caregiver and the role of health literacy

Note: This chapter has been published in the BMJ Open Paediatric: Dahmash DT, Shariff ZB, Kirby DJ, et al. Literature review of medication administration problems in paediatrics by parent/caregiver and the role of health literacy. BMJ Paediatrics Open 2020;4:e000841. doi: 10.1136/bmjpo-2020-000841

2.1 Introduction

When it comes to medication administration for children at home, a significant burden of responsibility relies on the parents or the patients themselves (Walsh et al., 2016). It's been documented that medication administration among children are well known to occur (Frush et al., 2004). Previous studies recognised that more than 40% of parents and caregivers make dosing errors in an outpatient setting. (LI et al., 2000;Simon and Weinkle, 1997) The inability to administer medication correctly may result in adverse drug events and poor patient clinical outcomes.(Sil et al., 2017) In the USA, errors at medication administration stage accounts for 26% of overall serious medication errors.(Leape, 1994) While in the UK, 237 million medication errors occurs annually among which avoidable ADEs are estimated to cost the NHS £98 462 582 per year.(Elliott et al., 2021) A prospective English study of ADEs and its causality reported that 5.2% of 18 820 admissions over 6 months were due to an ADE, among which 63% of these events are possibly avoidable.(Pirmohamed et al., 2004) ADEs due to medication administration at home among children and the causality of it was not identifiable within the literature. Causes of medication administration problems at home are multifactorial and potentially depend on various factors. (Frush et al., 2004) So in order to improve medication administration by parents and young patients (aged 16-18 years), an initial assessment of the current problems and factors that may contribute to this issue must be identified first.

Previous studies have recognised potential factors that can contribute to clinician led medication administration errors in children, but there have been no studies recording both the types and risk factors that can contribute towards caregiver's medication administration problems as well as young people. (Walsh et al., 2005;McPhillips et al., 2005) According to the European Health Literacy Survey (HLS-EU), conducted across eight different countries, the prevalence of low health literacy levels varies from 29% to 62%.(Rudd, 2007;Sørensen et al., 2015)

Owing to this high prevalence of low health literacy levels and its potential association with medication administration issues among children, this review aimed at identifying studies that

highlighted medication administration problems experienced by parents and children, which also looked at health literacy aspect using a validated tool to assess for literacy.

2.2 Method

This review was conducted in accordance with the Cochrane Handbook for Systematic Reviews, and followed PRISMA reporting guidelines. (Moher et al., 2010;Higgins JPT, March 2011) The review protocol is registered on International Prospective Register of Systematic Reviews (PROSPERO) ID: CRD42018091590 ***(See appendix A for the protocol published on PROSPERO).***

2.2.1 Eligibility Criteria

Studies were eligible for inclusion if they were related to medication administration errors among children and adolescent between the ages of 0 to 18 years old as per the World Health Organisation definition of population age group. This includes studies reporting medication related problems outside the clinical setting; where the parent or the child is responsible for administering or taking the medication. Studies must have assessed the health literacy levels of the participants using a validated health literacy assessment tool. Any study that looked only at education levels of the participants without assessing the literacy levels using a validated standardised health literacy tool was excluded; this include studies looking at the education levels of the participants without assessing the health literacy levels. The rationale behind this is that the level of education does not reflect the health literacy levels and ability of the adults to understand health related information such as administration instruction; distinguishing between dose and strength of the administered medication and other related health information. Health literacy is key element in this study to establish an understanding of its association with medication administration problems among children and young people; as poor literacy levels are surprisingly common in both developed and developing countries among adults (Kickbusch, 2001). Having this standardised criteria helped establish a clear understating of medication administration problems among children and young people in the light of health literacy. There were no restrictions on the date of publication, only English language articles studies where included.

2.2.2 Search Strategy

The search strategy was designed initially by the research team and verified by an information specialist using the Population, Intervention, Comparator and Outcomes (PICO) model. The reviewer (D.D.) systematically searched PubMed, Scopus, Web of Science, Cochrane Library, OpenGrey, NHS Digital Department of Health Office for National Statistics, BBC News, Bielefeld Academic Search Engine (BASE), E-thesis Online Service (EThOS) and Conference proceedings through Web of Science for studies from database inception to the 15th of September 2020.

Search terms summarised in ***(Table 2.1)*** included a comprehensive list of synonyms and multiple Boolean operators relating to: i) paediatric ii) medication error including dosing error, medication administration error, medication safety and medication optimisation and iii) health literacy. (D.D.) further performed reference tracking of all included studies to identify any potential studies to be included in the review.

Table 2. 1: Search Strategy for Systematic Review per database

Database	Search strategy
PubMed	((((child or children or pediatric* or paediatric* or toddler* or adolescent* or baby or babies or teen* or teenager* or youth or infant* or newborn* or neonate*))) AND (("medical error*" or "medication error*" or "medication administration error*" or "drug administration error*" or "medicine administration error*" or "medication safety" or "optimisation" or "optimization" or "dosing error*"))) AND (("health literacy" or "literacy" or "literate")).
Scopus	(child OR children OR pediatric* OR paediatric* OR toddler* OR adolescent* OR baby OR babies OR teen* OR teenager* OR youth OR infant* OR newborn* OR neonate*) AND (health AND literacy OR literacy OR literate) AND (medical AND error* OR medication AND error* OR medication AND administration AND error* OR drug AND administration AND error* OR medicine AND administration AND error* OR medication AND safety OR optimisation OR optimization OR dosing AND error*)

Database	Search strategy
Web of Science	TOPIC: (child or children or pediatric* or paediatric* or toddler* or adolescent* or baby or babies or teen* or youth* or infant* or newborn* or neonate*) AND TOPIC: ("health literacy" or "literacy" or "literate") AND TOPIC: ("medical error*" or "medication error*" or "medication safety" or "medication administration error*" or "medicine administration error*" or "drug administration error*" or "dosing error*" or "optimisation" or "optimization")
Cochrane Library	"health literacy" or "literacy" or "literate" in Title Abstract Keyword AND "medication error" or "medical error" or "medication administration error" or "medicine administration error" or "drug administration error" or "dosing error" or "medication safety" or "optimisation" or "optimization" in Title Abstract Keyword AND child or children or pediatric or paediatric or toddler or adolescent or baby or babies or teen or teenager or youth or infant or newborn or neonate in Title Abstract Keyword - (Word variations have been searched)

2.2.3 Study selection

Two reviewers (D.D., Z.S.) independently evaluated each study for eligibility to reduce bias using the inclusion criteria above. The titles and/or abstracts of all identified studies were reviewed independently, and full manuscripts that appeared to potentially relevant.

2.2.4 Data extraction process and synthesis

Two reviewers (D.D. and Z.S.) independently extracted data using a standardised predefined spreadsheet. Inconsistencies in extracted data were resolved through consensus discussion by a third reviewer (C.H.), if necessary. Results were synthesised and summarised according to analytical themes. Thematic analysis was opted by the research team as it`s known for its flexibility and ability of identifying patterns of meaningful information within the data. (Clarke et al., 2015)

2.2.5 Quality appraisal

The quality of the included papers was independently assessed by two reviewers (D.D., Z.S.) using the Critical Appraisal Skills Programme (CASP) checklists. (Critical Appraisal Skills Programme,

(2018)) The CASP tool was chosen as it allows for assessment of the rigour, credibility and relevance of the studies. The two reviewers resolved discrepancies through discussion and consensus discussions. For this review, assessment of the study quality was not used to guide inclusion or exclusion of studies but rather to moderate the findings of the review based on the quality of the studies contributing to the final analytical themes. The CASP tool for Randomized Controlled Trials has 11 items and the Qualitative checklist has 10 items, of which nine items are in a checklist form, with the possible answers to choose from being "Yes" "No" or "can't tell". (Critical Appraisal Skills Programme, 2018b;Critical Appraisal Skills Programme, 2018a) Two items among the randomized control trial tool and one from the qualitative CASP tool did not have these options and required discussion amongst the authors (D.D. and Z.S.).(Critical Appraisal Skills Programme, 2018a;Critical Appraisal Skills Programme, 2018b) Discrepancies were resolved through discussion and consensus.

2.3 Results

A total of 672 citations were retrieved from the database and other searches. After screening titles and abstracts, 38 publications were obtained in full text and assessed for suitability. Of which, 14 met the inclusion criteria and were included in the analysis ***(See Figure 2.1 for PRISMA flow chart).*** (Yin et al., 2014a;Yin et al., 2010;Yin et al., 2007;Samuels-Kalow et al., 2013;Yin et al., 2014b;Morrison et al., 2018;Harris et al., 2017;Wallace et al., 2012;Yin et al., 2017;Shonna Yin et al., 2016;Yin et al., 2008;Yin et al., 2011;Williams et al., 2019;Torres et al., 2018) See ***(Table 2.2)*** for reasons of exclusion**.**

The details of the 14 studies are presented in ***(Table 2.3 and 2.4).*** (Yin et al., 2014a;Yin et al., 2010;Yin et al., 2007;Samuels-Kalow et al., 2013;Yin et al., 2014b;Morrison et al., 2018;Harris et al., 2017;Wallace et al., 2012;Yin et al., 2017;Shonna Yin et al., 2016;Yin et al., 2008;Yin et al., 2011;Williams et al., 2019;Torres et al., 2018) The majority of the included studies were published in the last 12 years. All of the studies (n = 14) took place in the United States of America.

Overall, eleven studies recruited parents or caregivers of children aged between 30 days to less than 9 years old, two studies had recruited parents with no age limitations of the child and one study recruited only women of childbearing age. The majority of the studies (n = 13) did report the ethnic

composition of their recruited sample and they were vastly Hispanic or black African American parents or caregivers. One study had only exclusively recruited women from a white ethnic background. (Wallace et al., 2012)

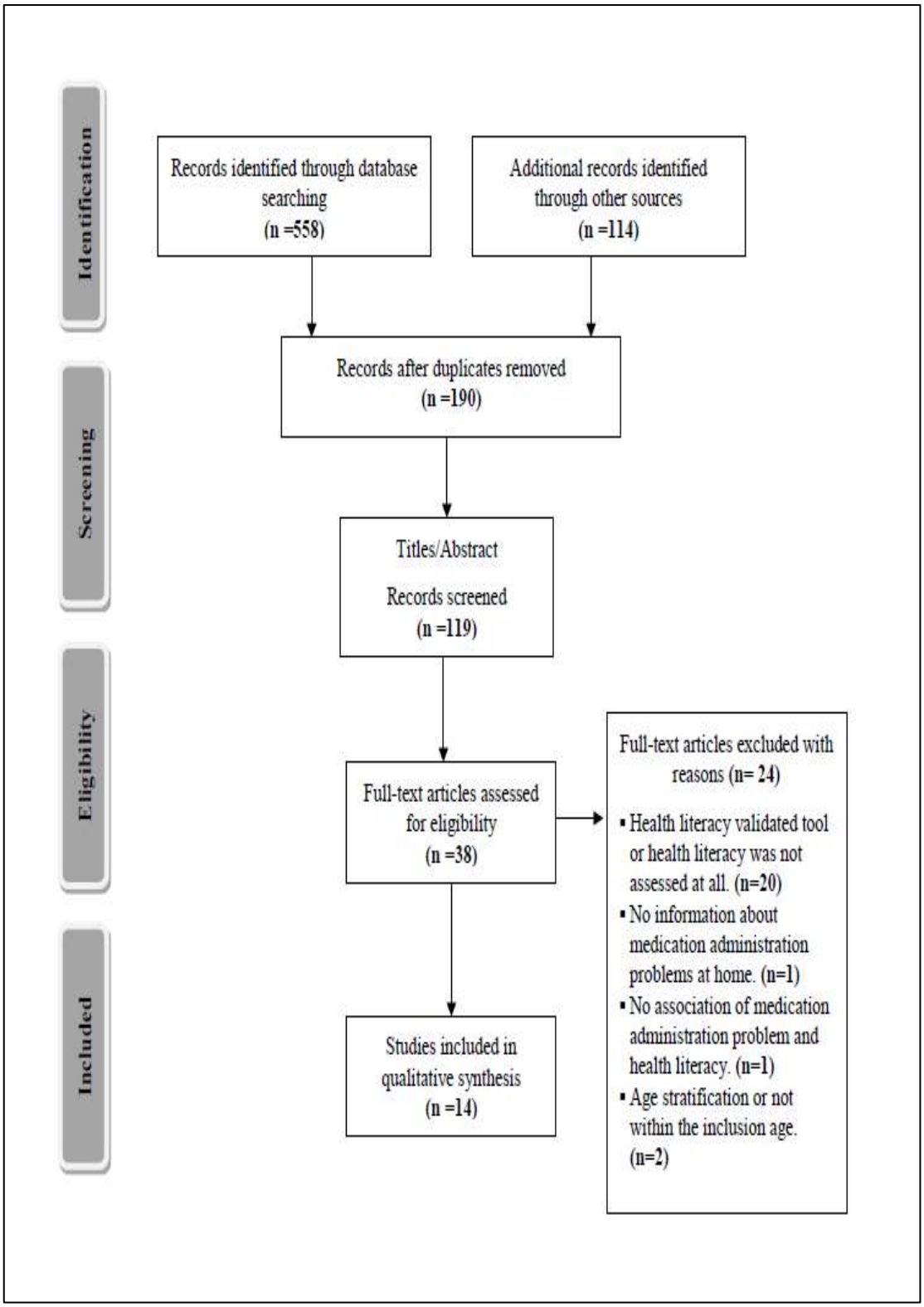

Figure 2. 1: Flow diagram for the study selection based on PRISMA flow diagram

Table 2. 2: Excluded studies at full text stage with reasons for exclusion

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
Almazrou, S. (2014)	Saudi Arabia	Ability of Saudi mothers to appropriately and accurately use dosing devices to administer oral liquid medications to their children	The study was designed to assess Saudi mother's experiences with measuring cups, syringes and droppers for oral liquid medications, and compared the accuracy of dosing across these devices	Health literacy levels was not tested.
Huang, W. T. (2015)	Taiwan	Immigrant mothers' knowledge of medication safety and administration for young children	The study aimed at comparing immigrant (Southeast Asian and Chinese) and non-immigrant (Taiwanese) mothers' knowledge of medication safety and administration for children, and to reveal how the accessibility of medical resources could affect immigrant mothers' medication administration.	Health literacy levels was not tested.
Boztepe, H. (2016)	Turkey	Administration of oral medication by parents at home	The study aimed at determining the practices and difficulties experiences by the parents at home when administering oral medication to their children.	Health literacy levels was not tested.
Chan, H. K. (2017)	Malaysia	Influences of pictogram-based instructions in paediatric drug labelling on dosing accuracy among caregivers: a pilot study from Malaysia	The study investigated the influence if pictographic dosing instructions used in paediatric drug labelling on dose accuracy.	Health literacy levels was not tested.
Chew, C. C. (2019)	Malaysia	Medication Safety at Home: A Qualitative Study on Caregivers of	The study designed to specifically explore the issues related to out-of-hospital medication	Health literacy levels was not tested.

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
		Chronically Ill Children in Malaysia	safety among the pediatric outpatients in Malaysia from the caregivers' perspective.	
Emmerton, L. (2014)	Australia	Management of children's fever by parents and caregivers: Practical measurement of functional health literacy	The study assessed the health literacy skills of parents and caregivers of children using a hypothetical dosing scenario of a child with fever.	Health literacy levels was not tested.
Joshi, P. (2019)	Mumbai	Liquid Drug Dosage Measurement Errors with Different Dosing Devices	The study was carried out to determine the magnitude of dosing errors made by parents of children aged under 5 years old, the most preferred drug delivery device and its association with age, gender, education of caregivers and number of children.	Health literacy levels was not tested.
Lee, C. H. (2017)	Taiwan	Inappropriate self-medication among adolescents and its association with lower medication literacy and substance use	The study assessed inappropriate self-medication among adolescents and examines the relationships among medication literacy, substance use, and inappropriate self-medication.	Health literacy levels was not tested.
Lubrano, R. (2016)	Italy	Acetaminophen administration in pediatric age: An observational prospective cross-sectional study	The study evaluated the appropriateness of the dosage of acetaminophen administered to children with fever, and the factors that may influence dosage accuracy.	Health literacy levels was not tested.
Ryu, G. S. (2012)	South Korea	Analysis of liquid medication dose errors made by patients and	The study was designed to determine the rate and magnitude of liquid medication dose errors that occur with	Health literacy levels was not tested.

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
		caregivers using alternative measuring devices	patient/caregiver use of various measuring devices in a community pharmacy.	
Sil, A.(2017)	India	A study of knowledge, attitude and practice regarding administration of pediatric dosage forms and allied health literacy of caregivers for children	The study assessed the knowledge, attitude and practices regarding medicine administration and literacy.	Health literacy levels was not tested.
Solanki, R. (2017)	India	Medication errors by caregivers at home in neonates discharged from the neonatal intensive care unit	The study determined the frequency of medication errors by caregivers at home in neonates discharged from the neonatal intensive care unit and to identify the associated risk factors.	Health literacy levels was not tested.
Tanner, S.(2014)	USA	Parents' understanding of and accuracy in using measuring devices to administer liquid oral pain medication	The study looked at dosing accuracy when parents used various measuring devices and aimed at identifying risk factors associated with dosing errors.	Health literacy levels was not tested.
Tobaiqy, M. (2020)	Saudi Arabia.	Parental Experience of Potential Adverse Drug Reactions Related to Their Oral Administration of Antipyretic Analgesic Medicines in Children in Saudi Arabia	The study explored parent's experience of potential adverse drug events after administering antipyretic analgesics. The study looked at adverse drug events after administering analgesics to children.	Health literacy levels was not tested.
You, M. A. (2015)	Korea	Parental experiences of medication	The study described parent's administration of medications to their	Health literacy levels was not tested.

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
		administration to children at home and understanding of adverse drug events	children at home and their understanding to adverse drug events.	
Glick, A. F. (2020)	USA	Accuracy of Parent Perception of Comprehension of Discharge Instructions: Role of Plan Complexity and Health Literacy	The study compared parents` perceived and actual comprehension of discharge instructions as well as assessed association between plan complexity and parent's health literacy with overestimation of comprehension.	No medication administration related information.
Brass, E. P. (2018)	USA	Medication Errors With Pediatric Liquid Acetaminophen After Standardization of Concentration and Packaging Improvements	The study assed the impact of the 2011 changes in paediatric single-ingredient liquid acetaminophen product packaging and standardization of the acetaminophen concertation on poison control centre exposure due to medication errors.	The study did not examined medication administration challenges, however, looked at reported medication errors on poison control centre.
Freedman, R. B.(2012)	USA	Influence of Parental Health Literacy and Dosing Responsibility on Pediatric Glaucoma Medication Adherence	The study assessed glaucoma medication adherence in children, hypothesising that poor parental health literacy and eye drop instillation by the child are associated with worse adherence.	The study examined medication adherence not administration errors.
Erickson, S. R.	USA	Health literacy and medication administration performance by caregivers of adults	The study determined the association between health literacy and a medication administration task assessment, as well as to identify caregiver characteristic	The study looked at medication administration in adults with disabilities not

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
		with developmental disabilities	associated with higher health literacy and medication administration task.	within the age range of this review.
Taybeh, E. (2020)	Jordan	The awareness of the Jordanian population about OTC medications: A cross-sectional study	The study evaluated the knowledge and attitudes towards the use of OTC products.	The targeted population was adults and not within the specific age group that this review was aimed at.
Walsh, K. E. (2011)	USA	Medication errors in the homes of children with chronic conditions	The study observed and described the types of medication errors occurring at home of children with chronic disease.	Unable to extract data for children aged 0 to 18 years old from the final analysis, which included adult data.
Walsh, K. E. (2013)	USA	Medication errors in the home: A multisite study of children with cancer	The study described the types of errors occurring in the home medication management of children with cancer.	Unable to extract data for children aged 0 to 18 years old from the final analysis, which included adult data.
Shone, L. P. (2011)	USA	Misunderstanding and potential unintended misuse of acetaminophen among adolescents and young adults	The study assessed adolescents` s (ages 16 to 23 years) health literacy, knowledge about acetaminophen, recent use of over the counter medicines and understanding of medication dosing instructions.	Unable to extract data of children aged between 16 and 18 years old from the adult data.
Manchanayake, M. G. C. A. (2018)	Sri Lanka	Patients' ability to read and understand dosing instructions of their own medicines - A	Looking at adult's participants and their overall knowledge in regards to written dosing instructions provided by the pharmacists on dispensing labels.	Younger people aged 18 years old data was no stratified from the adult data.

Author	Country of Origin	Study Title	Aim of the Study	Reason For Exclusion
		cross sectional study in a hospital and community pharmacy setting		

Table 2. 3: Characteristics of the randomised controlled experiment included in the review (listed by health literacy test).

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
Wallace et al. (2012) (Wallace et al., 2012)	Outpatient clinic	Randomized Controlled Trial	To address the gap by addressing whether instructions wording that implicit versus explicit dosage intervals was associated with participant's ability to describe and correctly measure a dose of a commonly prescribed liquid pediatric prescription medication.	Women of childbearing age.	193	Estimated using three established items: -How often do you have problems learning about your medical condition because of difficulty understanding written information? - How often do you have someone help you read hospital materials?	One third of the participants (32.1%) were able to describe and measure the dose accurately. Participants with inadequate health literacy skills were one third as likely to measure a dose of the medication correctly.

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
						- How confident are you filling out medical forms by yourself?	
Shonna Yin et al. (2016)[Shonna Yin et al., 2016]	Pediatric clinic	Randomized controlled experiment	Hypothesized that unit concordance would be associated with fewer errors and that parents would measure most accurately with syringes. Secondly, they also sought to examine differences in impact by parents' health literacy and language because low health literacy and limited English proficiency are	Parents of children aged ≤ 8 years old.	2099 parents	Newest Vital Sign (NVS)	Nearly all parents (99.3%) measured ≥ 1 dose that was not the exact amount. Overdoing (68.0%) was the majority of the errors. Dose amount of 2.5 and 7.5 ml was associated with more errors when compared with 5 ml(2.5 vs 5 ml adjusted odds ratio [aOR]=4.2; 95% CI,3.8-4.6; 7.5 vs 5 ml [aOR]= 1.4;95%CI, 1.2-1.5).

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
			factors known to place children at risk for errors.				
Harris et al. (2017)[Harris et al., 2017]	Outpatient	Randomized Controlled Experiment	To examine the association between health literacy and limited English proficiency and liquid medication dosing errors in Hispanic parents	Hispanic parents of children <8 years old.	1126 parents	Newest Vital Sign (NVS)	70% of the recruited parents had Limited English Proficiency (LEP), 82.7% had limited literacy. Of parents who had Limited English Proficiency (LEP) 88.8% had limited and 11.2% adequate health literacy. 83.1% of parents made a dosing error at least one out of the nine dosing trials. Parents with limited health literacy and with Limited English Proficiency (LEP) made the most dosing error and errors varied by dose amount and tool type.
Yin et al. (2011) [Yin et al., 2011]	Outpatient pediatric clinic	Randomized Controlled Trail	To sought whether a pictographic dosing diagram included as part	Parents or caregiver of a child with no	299 parents	Newest Vital Sign (NVS)	Both groups were associated with poor dosing with the tendency for the parents who have received text plus pictogram significantly less

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
			of written instructions can decrease parent errors in dosing infant acetaminophen as well as whether pictogram benefit varies by parent health literacy level.	specific age limitation.	were assessed		likely to make dosing error (0.6%) compared with parents who received text only instructions (5.6%). Parents with low literacy who received the text plus pictogram instructions were significantly less likely to make errors in dosing compared with who received text only instructions(50.4% vs 66.4%; *P*=.02).
Yin et al. (2017) (Yin et al., 2017)	Pediatric outpatient clinic	Randomized controlled experiment	To examine the degree to which errors could be reduced with pictographic diagrams, millilitre-only units, and provision of tools more closely matched to prescribed volumes	Parents of children aged ≤ 8 years old.	2099 for all arms	Newest Vital Sign (NVS)	Majority of the parents (99.3%) made dosing errors. More errors with the 2 and 7.5 ml dosing amount when compared with the 10 ml (2ml vs 10 ml aOR =3.7; 7.5 ml vs 10 ml aOR= 1.4). Parents who received text and pictogram dosing instructions with ml only labels and tools had decreased odds of making a dosing error compared with received ml/tsp labels and

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
							tools with or without pictographic dosing instructions.
Yin et al. (2008) (Yin et al., 2008)	Pediatric emergency department	Randomized Controlled Trial	To evaluate the efficacy of a pictogram based health literacy intervention to decrease liquid medication administration errors by caregivers of young children.	Parents and caregivers of children aged 30 days to 8 years.	245	Test of Functional Health Literacy in Adults (TOFHLA)	Caregiver's dose accuracy was higher among the intervention group prescribed daily and as needed medications regardless of the cut-off point was 20% or 40%. 5.4% of the intervention caregivers whose children had been prescribed daily doses gave inaccurate dose at the 20% cut- off point, compared with 47.8% of control caregivers. The study suggested that there is no health literacy association with the dosing errors.

Table 2. 4: Characteristics of the observational included studies in the review (listed by health literacy test).

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
Morrison et al. (2017) (Morrison et al., 2018)	Outpatient clinic and emergency department	Interviews and applied assessment	To examine the association between parent health literacy and pain medication knowledge and applied skills in parents of children with sickle cell disease.	Parents of children 1 to 12 years old.	100	Newest Vital Sign (NVS)	Parents with low health literacy made more under dose frequency errors on the pain treatment skills. Health literacy was not associated with errors on the applied treatment skills. Parents recalled underdosing of medication (both dose and frequency). On the applied pain treatment skills, parents made both underdoing and overdosing errors.
Torres et al. (2018)(Torres et al., 2018)	Paediatric outpatient clinics	Cross sectional analysis	Sought to examine the interrelationships between parents` preferences and perceptions regarding unites of measurement, parents millilitre dosing experiences,	`Parents or legal guardian of children ≤ 8 years old.	493	Newest Vital Sign (NVS)	Parents preferred the millilitre dosing to be easy; few 11.5% prefers teaspoon units. Parents will low health literacy levels had a higher odd of having a teaspoon preference and greater odds of perceiving difficulty with the millilitre only dosing.

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
			and parent health literacy.				
Williams et al. (2019)[Williams et al., 2019]	Outpatient clinics	Cross sectional analysis	To assess parent decision-making regarding dosing tools, a known contributor to medication dosing errors, by evaluating parent dosing tool use, beliefs, and access, and the role of health literacy, with a focus on dosing cups, which are associated with an increased risk of multi-fold overdose.	Parents or legal guardians of children aged ≤ 8 years old.	473	Newest Vital Sign (NVS)	Health literacy is one of the factors that could be associated with the dosing tool choice. Parents with limited health literacy reported that dosing cups were the tool used most of the time.

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
Yin et al. (2010) (Yin et al., 2010)	Paediatric clinic	Observational	To assess parents` liquid medication administration errors by dosing instrument type and to examine the degree to which parents` health literacy influences dosing accuracy.	Parents of children with no specific age limitation.	302(287 mothers, 8 fathers, 7 legal guardians)	Newest Vital Sign (NVS)	Health literacy was significantly related to doing errors with the cups as well as the dosing spoon, while non-significant trend was seen for the dropper and the oral syringes with the bottle adaptor.
Samuels-Kalow et al. (2013) (Samuels-Kalow et al., 2013)	Tertiary	Prospective observational	To examine language-based disparities in discharge communication and parental understanding of discharge instructions.	Parents of children 2 to 24 months.	145	Short Test of Functional Health Literacy (S-TOFHLA)	Parents had acetaminophen dosing errors. There is significant association between language and dosing errors. Parents with marginal or inadequate health literacy had dosing errors compared with adequate health literacy.

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
Yin et al. (2014) (Yin et al., 2014a)	Paediatric emergency department	Interviews and observations	To examine the degree to which recommended provider-counselling strategies, including advanced communication techniques and dosing instruments provision, are associated with reductions in parents liquid medication dosing errors.	Parents of children aged < 8 years old.	287	Short Test of Functional Health Literacy (S-TOFHLA)	Majority of the patents made underdoing errors as well as few made overdosing errors. Recipient of at least one advanced counselling were less likely to make a dosing error compared with those who did not report received advanced counselling. Parent who received dosing instrument from the emergency department made fewer errors. For adequate health literacy levels was significantly associated with fewer errors when they have received advanced counselling in combination with instrument provision but not the low literacy.
Shonna Yin et al. (2014)(Yin et al., 2014b)	Emergency department	Interviews and observations	To examine the association between unit used and parent medication errors and whether nonstandard	Parents of children aged <9 years old.	400	Short Test of Functional Health Literacy in Adults (S-TOFHLA)	Parents made different kind of error in measurement. 1 in 6 parents used kitchen spoon rather than a standard instrument. Parents did not used the unit listed on the prescription or label.

Study Information		Participants Characteristics			Findings		
First Author (Year)	**Setting**	**Methods**	**Aim**	**Age of the recruited sample**	**Sample Size**	**Health Literacy test used**	**Outcomes and gaps**
			instruments mediate the relationship.				
Yin et al. (2007)[Yin et al., 2007]	Paediatric emergency department.	Interviews	To assess whether low caregiver health literacy was related to risk factors for liquid medication dosing errors, including reported use of non-standardised dosing tools and lack of knowledge about weight based dosing.	Parents and caregivers of children aged between 30 days to 8 years old.	292	Test of Functional Health Literacy in Adults (TOFHLA)	Low health literacy, particularly reading comprehension, was associated with reported use of non-standardised dosing instruments and lack of knowledge regarding weight based dosing. In addition, this has been found previously to be associated with decreased dosing accuracy.

2.3.1 Quality appraisal

All identified studies were included in the final synthesis with a greater emphasis on the higher quality studies. The randomised trial studies were appraised using the CASP checklist for Randomized Controlled Trials and results are summarized in ***(Table 2.5)***. All of the studies had clearly addressed a focused issue to be investigated. Five trials out of the six had similar participant characteristics at the beginning of the trial, with the exception of one study, which the authors (D.D. and Z.S.) could not tell if there was similar characteristic in control and intervention groups. (Harris et al., 2017) Apart from the intervention given, all the study participants were treated similarly. All studies had stated clearly the study primary outcomes. All of the studies discussed the sample size and the rationale behind the sample size recruited number, except for two studies. (Harris et al., 2017) (Wallace et al., 2012) All studies had an exact ρ statistical significance and Confidence Intervals (CI) values estimated for the primary outcomes. Finally, all included clinical trials had an importance clinical value that could help to inform future work with minimal risks added.

Results of the appraisal for the qualitative studies are presented in **(*Table 2.6)***. All of the qualitative studies included in this review provided a clear statement of the aims, used appropriate qualitative methodology and design and employed an appropriate recruitment strategy and provided a sufficient information about data collection. Two of the studies had unclear information that can relate to the researcher considering their role and potential bias. (Morrison et al., 2018) Finally, all studies stated the ethical approval that had been obtained to commence the study, and discussed in detail the findings in light of existing literature and provided future implications for practice.

Table 2. 5: Quality appraisal of included studies using the Critical Appraisal Skills Programme (CASP) Randomised Controlled Trials Research Checklist. (Critical Appraisal Skills Programme, 2018b)

CASP Question Number	**Authors and date**					
	Yin (2017) (Yin et al., 2017)	Harris et al. (2017) (Harris et al., 2017)	Shonna Yin et al. (2016)(Shonna Yin et al., 2016)	Yin et al. (2008) (Yin et al., 2008)	Yin et al. (2011) (Yin et al., 2011)	Wallace et al. (2012) (Wallace et al., 2012)
1. Did the trial address a clearly focused issue?	Yes	Yes	Yes	Yes	Yes	Yes
2. Was the assignment of patients to treatments randomised?	Yes	Yes	Yes	Yes	Yes	Yes
3. Were all of the patients who entered the trial properly accounted for at its conclusion?	Yes	Yes	Yes	Yes	Yes	Yes
4. Were patients, health workers and study personnel 'blind' to treatment?	No	No	No	No	No	No
5. Were the groups similar at the start of the trial	Yes	Can`t Tell	Yes	Yes	Yes	Yes
6. Aside from the experimental intervention, were the groups treated equally?	No	Yes	Yes	Yes	Yes	Yes
7. How large was the treatment effect? [a]	Yes	Uncertain	Yes	Yes	Yes	Uncertain
8. How precise was the estimate of the treatment effect? [b]	Yes	Yes	Yes	Yes	Yes	Yes
9. Can the results be applied to the local population, or in your context?	No	No	No	No	No	No
10. Were all clinically important outcomes considered?	Yes	Yes	Yes	Yes	Yes	Yes

11. Are the benefits worth the harms and costs?	Yes	Yes	Yes	Yes	Yes	Yes

[a] Based on the power calculation of the sample size and the primary outcomes results stated clearly.

[b] Based on the extract $\boldsymbol{\rho}$ value and CI value of the primary outcome.

Table 2. 6: Quality appraisal of included studies using the Critical Appraisal Skills Programme (CASP) Qualitative Research Checklist.(Critical Appraisal Skills Programme, 2018a)

CASP Question Number	Authors and date							
	Williams et al. (2019)(Williams et al., 2019)	Torres et al. (2018)(Torres et al., 2018)	Morrison et al. (2017)(Morrison et al., 2018)	Shonna Yin et al. (2014)(Shonna Yin et al., 2014)	Samuels-Kalow et al. (2013) (Samuels-Kalow et al., 2013)	Yin et al. (2007)(Yin et al., 2007)	Yin et al. (2010) (Yin et al., 2010)	Yin et al. (2014) (Yin et al., 2014a)
1. Was there a clear statement of the aims of the research?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Is a qualitative methodology appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Was the research design appropriate to address the aims of the research?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Was the recruitment strategy appropriate to the aims of the research?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Was the data collected in a way that addressed the research issues?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Has the relationship between researcher and participants been adequately considered?	Yes	Yes	Can`t Tell	Can`t Tell	Yes	Yes	Yes	Can`t Tell

7.	Have ethical issues been taken into consideration?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8.	Was the data analysis sufficiently rigorous?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9.	Is there a clear statement of findings?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10.	Is there a Value of the research?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2.3.2 Synthesis of results

The data from the 14 studies were analysed and three analytical themes emerged from the analysis and a summary of the review results are demonstrated in ***(Figure 2.2)***.

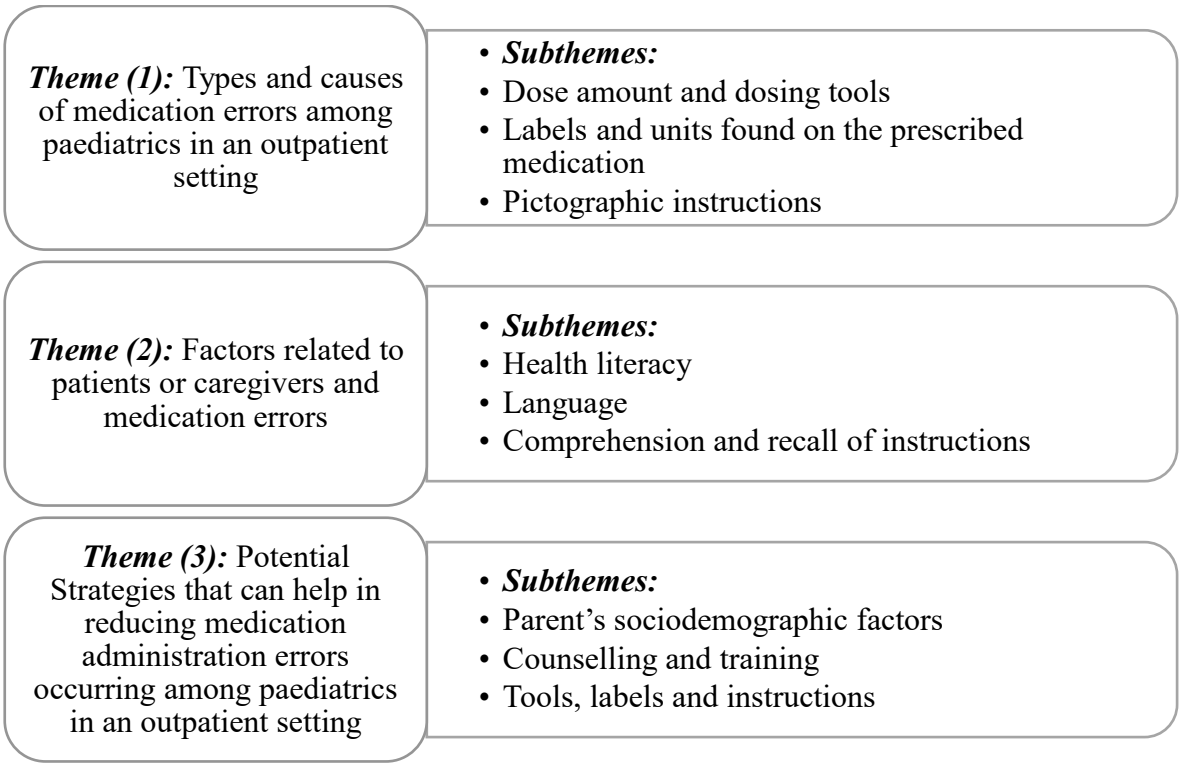

Figure 2. 2: List of the review results

2.3.2.1 Types and causes of medication administration errors among children led by parents or child outside a clinical setting:

Eight of the included studies indicated that paediatric dosing errors are among the most common medication errors made by parents. (Yin et al., 2014a;Samuels-Kalow et al., 2013;Morrison et al., 2018;Harris et al., 2017;Yin et al., 2017;Shonna Yin et al., 2016;Yin et al., 2011;Yin et al., 2014b) Among these studies, two randomised trials identified that overdosing errors are more common among parents.(Yin et al., 2017;Shonna Yin et al., 2016) While another cross sectional study looking at parents with child on a short course prescribed medication reported that the majority of the parents measured below the prescribed dose.(Yin et al., 2014a) A study by Morrison et al. reported that parents who made underdosing errors made more dosage errors and frequency errors compared with those who made an overdosing error.(Morrison et al., 2018)

From the included studies, it was noticed that the magnitude and frequency of dosing errors by parents were influenced by two factors: measurement tool used by parents and the dose volume (amount). In one study, parents stated that non-standardised kitchen spoon was their primary dosing tool.(Yin et al., 2007) Two studies reported that errors were more common with measuring cups than with syringes, in particularly with small dose volumes (amounts). (Harris et al., 2017;Shonna Yin et al., 2016) In a cross sectional study conducted in the USA, the majority 66% of the parents considered oral syringes are the best tool for dosing accuracy, while 23.5% believed that cups were the best, however, few 10.1% believed that dosing spoon, measuring spoon, kitchen teaspoon and droppers were the best.(Williams et al., 2019). Another study reported that larger dosing errors; (>40% deviation of the recommended dose) were made by parents using cups with printed marking and etched markings, this was thought to be due to confusion about teaspoon vs tablespoon instructions, assumptions that the cup is the unit of measure and the full cup is the dose. (Yin et al., 2010) Labels and units of the prescribed medication were contributing factors to dosing errors. (Shonna Yin et al., 2016) Parents made significant dosing errors when the units found on the medication bottle label were not similar to the units used on the dosing tool. (Shonna Yin et al., 2016) Parents who used teaspoon/tablespoon units were likely to use a non-standardised dosing instrument and make errors in measuring the prescribed and intended dose. (Yin et al., 2014b) The final potential factor was the type of instructions provided. For liquid medication, less errors were seen among parents who were provided with text-plus-pictogram instructions 43.9% compared with text-only instructions 59.0% and this group were also less likely to make overdosing errors. (Yin et al., 2011) Parents who received standard medication counselling were 47.8% more likely to make dosing errors when compared with parents who received pictogram instruction (5.4%).(Yin et al., 2008)

2.3.2.2 Factors related to patients or caregivers and medication errors

2.3.2.2.1 Health Literacy

Health literacy of caregivers in the studies were assessed, six conducted further analyses of its influence on dose accuracy and other co-factors related to medication errors. Yin *et al.* reported that caregivers with inadequate or marginal health literacy were more likely to use a non-standardised

dosing instrument and further lacked knowledge on weight based dosing for over the counter medication when compared with caregivers with adequate health literacy. (Yin et al., 2007) Another study by Yin *et al.*, found a significant association between health literacy and dosing errors using cups and dosing spoons. (Yin et al., 2010) In adjusted analysis conducted by Williams *et al.*, they found that there was a strong association between health literacy levels and measurement tool preference in particular cups, parents with limited literacy reported that dosing cups were the tool of choice most of the time (aOR=2.4). (Williams et al., 2019) The use of a teaspoon/tablespoon was associated with errors in the intended dose for those with low health literacy but not for those with adequate health literacy. (Yin et al., 2014b) Harris *et al.* identified that parents with limited health literacy and Limited English Proficiency (LEP) made the most dosing errors. (Harris et al., 2017) Similarly, Kalow *et al.* revealed that parents with inadequate and marginal health literacy committed dosing errors, but the sample size of this group was small compared with the adequate health literacy group. (Samuels-Kalow et al., 2013)

2.3.2.2.2 **Language**

Association between health literacy and lack of knowledge of weight-based dosing varied by English speaking caregiver's. For English speaking caregivers 88.6% of inadequate or marginal health literacy caregivers were unaware of weight based dosing in comparison to 54.1% of caregivers with adequate health literacy. (Yin et al., 2007) In contrast, Yin *et al.* found that there was no significant relation between dosing error and (LEP).(Yin et al., 2011) However, there were some differences in teaspoon-associated errors in measurement by language. (Yin et al., 2014b)

2.3.2.3 Comprehension and recall of instructions in relation to parent sociodemographic status

Yin *et al.* reported that parents from a low sociodemographic status who were prescribed a daily dose and who received a simple language, pictogram instructions sheets, were less likely to make errors in knowledge of dose frequency and dose accuracy compared with the control group who received standard medication counselling (0% vs 15.1%).(Yin et al., 2008) Participants among the interventional group were less likely to report incorrect medication preparation related to shaking the

medication before administration for both daily doses (10.9% vs 28.3% P= 0.04) and as needed medication (21.5% vs 43.0%).(Yin et al., 2008) Participants in the interventional group were less likely to use a non-standardised measurement tool compared with the parents in the standard group (daily dose: 93.5% vs 71.7%; as needed: 93.7% vs 74.7%).(Yin et al., 2008) Torres *et al.* a cross-sectional study that analysed data from a randomised control study, looked at parents preference and perceptions in regards to units of measurements. It was found that over 80% of the parents perceived a change to millilitre only instructions would be easy in comparison to 14% found it somehow hard and 4.1% very hard.(Torres et al., 2018)

2.3.2.4 Interventions aimed at reducing medication administration errors occurring among children outside a clinical setting

2.3.2.4.1 Parent's sociodemographic factors

Four studies suggested that parental sociodemographic risk factors should be considered when designing an intervention aimed at averting medication administration errors.(Yin et al., 2010;Yin et al., 2007;Harris et al., 2017;Yin et al., 2011) Amongst these factors were parents' health literacy as well as language. Kalow and his colleagues suggested that efforts to streamline interpreter services must be continued as well, to having a more formalised approach in place to elucidate the patient's preferred language for communication. (Samuels-Kalow et al., 2013)

2.3.2.4.2 Counselling and training

2.3.2.4.3 **Three studies suggested that provision of dose counselling (showing the patient how to prepare the dose) in combination with verbal counselling could be associated with less dosing errors. (Yin et al., 2014a;Yin et al., 2007;Yin et al., 2017) A study by Yin *et al.* indicated that errors occur across different counselling approaches, and they have recommended developing new strategies to ensure that parents understand medication instructions as well as the need for further research to identify the best counselling strategies and how to incorporate these within clinical practice. (Yin et al., 2014a) Yin *et al.* suggested the need for**

intensive teaching, training and coaching programmes that can accommodate for different parental health literacy levels. (Shonna Yin et al., 2016) Tools, labels and instructions

Yin *et al*. suggested a promising strategy that could potentially help to reduce paediatric-dosing errors, which was to match the dosing tool with the prescribed dose volume and move towards more simplified numerical markings on the measurement tools as well as to move to millilitre-only units (Shonna Yin et al., 2016;Yin et al., 2011;Torres et al., 2018). Wallace *et al.* indicated in his study that some parents would prefer instructions with explicit dosage intervals with the exact time and dose to be specified on the label.(Wallace et al., 2012) Harris *et al*. suggested improving the availability of language concordant labels that could accommodate for different health literacy levels.(Harris et al., 2017) Three studies from this review strongly suggested the importance of utilising pictographic dosing instructions and how it could be a positive aid in reducing paediatric dosing errors.(Yin et al., 2017;Yin et al., 2011;Yin et al., 2008) Majority of parents would be comfortable with millilitre dosing instructions only.

2.4 Discussion

The results of this study suggest that parents appear to make a range of medication errors, particularly with liquid medications as documented by prior studies that were conducted also in the USA as well as studies from this review. (Yin et al., 2017;Frush et al., 2004;Simon and Weinkle, 1997;Yin et al., 2008) The majority of the included studies indicated that dosing errors were amongst the most common medication errors made by parents, which is consistent with another study, which was conducted on Spanish–speaking Latino parents.(Harris et al., 2017;Leyva et al., 2005;Yin et al., 2008;Yin et al., 2014b;Yin et al., 2014a)This review identified possible causality behind parents dosing errors other than just the effect of health literacy; these errors could be linked to the: dose volume prescribed, measurement tools used, units used on the labels and the instructions provided.

Although standardised measurement tools are usually dispensed with the prescribed liquid medications in the UK, this review identified that the studies published in the USA indicated that parents still use non-standardised liquid dosing tools as their primary measuring tool; this has been

previously linked with medication administration errors by both Yaffe *et al.* and McMahon et al. (McMahon et al., 1997;Yaffe et al., 1975) The review found that pairing the medication labels to the closest measurement tool size, particularly for millilitre-only labels and tools, could be associated with a reduction in parent dosing and administrating error rates, as well as a decrease in the likelihood of parents using non-standardised measurement tools as suggested by another research. (Yin et al., 2014b) (Yin et al., 2016)

The review showed that the use of simple pictographic based medication instructions with explicit dosage intervals could reduce dosing errors by parents. This finding was consistent with previous existing data from both South and West Africa as well as the USA regarding the use of pictographic illustrations as a supportive tool to aid parents in administering medication to their children correctly. (Dowse and Ehlers, 1998;Dowse and Ehlers, 2005;Dowse and Ehlers, 2001;Mansoor and Dowse, 2003;Houts et al., 2006;Houts et al., 1998;Katz et al., 2006;Morrow et al., 1998;Ngoh and Shepherd, 1997) Potentially this could benefit both parents and caregivers with limited or low health literacy levels.

The findings of this review are consistent with prior USA studies investigating the link between adult`s sociodemographic factors, particularly health literacy, and medication administration problems.(Davis et al., 2006;Kripalani et al., 2006;Kalichman et al., 1999;Graham et al., 2007) Four studies explicitly highlighted that sociodemographic factors, such as health literacy and language, must be incorporated into any future intervention that aims to reduce parental dosing and administration errors.

The results of the review highlighted several interventions to aid parents and patients to potentially reduce medication administration errors at home. This include the use of plain language combined with provision of using the dosing tool provided as well as incorporating pictographic instructions which were consistent in four of the included studies. (Yin et al., 2017;Yin et al., 2008;Yin et al., 2011;Yin et al., 2014a) Pictographic-plain instructions significantly improve the accuracy of dosing and administering medication to children especially for those parents with insufficient health literacy. (Yin et al., 2008;Yin et al., 2011)

This study emphasised potential areas that could be incorporated into real practice that could help with reducing medication administration errors done by parents/caregivers and patients. Potential strategies include personalised training and coaching that accommodate different health literacy levels and languages as well as the possibility to match the dosing tool with the prescribed volume alongside the use of millilitre units. Although, Shared Decision Making (SDM) is a well-established component of patient care, yet its application in the paediatric field in not well understood as the child parent will be the surrogate for the real patient.(Bauchner, 2001) This strategy comes with a challenge especially when multiple carers are involved in the process of medication administration. This could sometimes lead to medication administration errors if a dose has been changed and not all people who are involved in the medication administration process were informed.

This review is subject to several limitations. There were two major limitations to our study. Firstly, English studies were only included, so publication bias may exist and non-English studies that are related to this topic might have been missed. Secondly, only studies that evaluated literacy using a validated tool were included. This resulted in only studies from the USA being included. The excluded studies that are of relevance to the topic, but outside the scope of this review are listed in ***(Table 2.2)*** as these studies did not assess parental health literacy using a validated tool.. Literacy is a problem worldwide, but of greater importance in low and middle-income countries. Future reviews should include these studies by broadening the search strategy.

Furthermore, although the study aimed at including medication administration challenges for younger people aged between 16 to 18 years old, however, none of the included studies had information on young people aged 16 to 18 years old, although few were identified but did not pass the eligibility criteria for this review. Future research are needed where younger people aged 16 to 18 years old are included as participants. In addition, the generalisability of the study results maybe low, this is because the majority of the studies were conducted in the USA and emerged from the same research group Yin *et al.* This research group, have highlighted in their studies several limitations, such as the use of hypothetical scenarios that might not be a true reflection on how parents measure the dose at home. (Yin et al., 2010;Yin et al., 2017;Shonna Yin et al., 2016;Yin et al., 2011). For some randomised trial studies in this review, it was difficult for the research team to maintain

blindness as some of the participants revealed their allocated group, while for the cross sectional studies, no conclusion of the causes could be drawn.(Yin et al., 2007;Yin et al., 2008;Yin et al., 2014b) Finally, the date of publication for one of the studies was 13 years old (Yin et al., 2007), which would not take into account the changes that have occurred in terms of interventions that would vary locally, nationally and internationally. However, this review highlights that non-standard dosing still occurs to date due to parent preference based on recent evidence in 2018 (Torres et al., 2018).

2.5 Conclusion

The findings suggest that in order to optimise medication use by parents, further work is needed to address the nature of these issues at home. Counselling, medication administration instructions and measurement tools are some of the areas in addition to the sociodemographic characteristics of parents and young people are among the factors to be considered when designing any future potential intervention aimed at reducing medication errors among children and young people at home.

Chapter 3 –NPPG Survey-Pharmacists' perspectives on medication administration problems at home among children and young people-an online survey

3.1 Introduction

At home, children rely on their parents for medication administration; yet, over 40% of caregivers in the home setting make dosing errors, placing children at risk of injury (Yin et al., 2010). In one prospective observational study, 72 medication errors were identified, among which 63.5% were related to drug administration at home by parents (Walsh et al., 2013).

Pharmacy staff regularly deal with paediatric medication-related needs, encountering challenges with regards to medication administration to children (e.g. dose adjustments, appropriate measuring devices) and dealing with queries from parents regarding their child's medication (e.g. ability to measure out a required dose, taste issues, manipulation of dosage forms).(Benavides et al., 2011;Brown et al., 2019) Therefore, this study aims to identify the specialist pharmacy team's perspective with regards to medication administration challenges occurring in children and young people in the home setting.

3.2 Method

3.2.1 Targeted sample

An online survey using JISC Online Surveys tool was designed to ascertain, from a pharmacy team perspective, the current challenges and obstacles that patients, parents or caregivers face during medication administration among children and young people in the home setting, based on feedback and queries. This group consist of specialist pharmacists, technicians, dispensers and other pharmacy related academics that share a passion in the paediatric population in the United Kingdom. Ethical approval for this study was obtained from the ethical committee of the School of Life and Health Sciences, Aston University ***(See appendix B for the ethical approval application)***.

3.2.2 The survey

The survey contained three main sections; each section consisted of several open and closed questions, designed by experts in this area to overview the current issues among children pertinent

to medication administration at home from a pharmacy team perspective ***(See appendix C for the survey questions)***. The three main sections are the following:

1- **Demographic background of the participants:** questions included in this section - the participants' role, the sector they work in, how long they have been registered as a pharmacist and where they are currently practising.

2- **Dosage forms preference among paediatric patients and how to enhance medication administration accuracy:** question included in this section - the role of the participant in managing a child medication prescription, the participant opinion on whether parents or caregivers require training when it comes to medication administration, the participant`s concerns when a new medication is prescribed to children and young people aged 0 to 18 years old, and the most commonly used dosage forms for children as well as the most common measurement tool dispensed with liquid dosage forms.

3- **Medication administration and expert recommendations:** question in this section - based on the participant experience: what would be the priority to improve medication administration among children at home, what would be the challenging dosage formulations and entities used in children and young people aged 0 to 18 years of age, which age group is the most challenging in regards to medication administration among children and recommendations in regards to medication administration among children at home.

3.2.3 Distribution process

Before distribution, the survey was piloted by three academics who are experts in pharmacy practice and paediatric dosage formulation, and by two registered pharmacists in the UK.

An invitation e-mail and link to the survey were sent to the Neonatal and Paediatric Pharmacists Group (NPPG) members through the group's administrative office, and permission was granted to circulate the link via e-mail to all registered members of the group (approximately 300 members). The survey was conducted between 26th of November 2018 and the 1st of April 2019.

3.2.4 Data analysis

The survey was analysed thematically, guided by approaches outlined by Braun and Clark (Braun and Clarke, 2006). All results were exported to a Microsoft Excel 2016 spreadsheet and were analysed by (DD). Overall, two themes emerged from this survey:

1- Pharmacy professional`s concerns and expectations regarding medication administration performed by parents for children at home
2- Pharmacy professionals' recommendations to support parents while administering medication to their children

3.3 Results

3.3.1 Respondents and Demographics

Of the 38 participants, 37 were pharmacists, and one was a technician. Among the respondents, the majority 22 (57.9%) were principally working in a Specialist Children`s Hospital, and 16 (42.1%) have been registered as a pharmacist for more than 18 years and were mainly 23 (60.5%) practising in England. ***(Table 3.1)*** describes the respondents' demographics and role in managing medication for children.

Table 3. 1: Summary of the respondent's demographics

Questions	Responses	Number of Respondents (n = 38)
Please select one sector that you work in principally (e.g. your main employment sector)	A General Hospital A Specialist Children`s Hospital	16 (42.1) 22 (57.9)
How long have you been a UK registered pharmacist?	0-3 Years 4-6 Years 7-10 Years 11-14 Years 15-18 Years More than 18 Years Not registered	1 (2.6%) 4 (10.5%) 6 (15.8%) 3 (7.9%) 6 (15.8%) 16 (42.1%) 2 (5.3%)
Where do you practise?	England Northern Ireland Outside UK Scotland Wales	23 (60.5%) 1 (2.6%) 6 (15.8%) 4 (10.5%) 4 (10.5%)
Please tick all that apply regarding your role in managing a child's medication: prescription	Procuring Dispensing Managing unlicensed prescription Clinically checking medication Dosing medication reconciliation Drug history taking Discharge medication list screening Counselling patients/parents/caregivers on their medication Other	27 (71.1%) 27 (71.1%) 34 (89.5%) 37 (97.4%) 37 (97.4%) 37 (97.4%) 34 (89.5%) 38 (100%) 7 (18.4%)

3.3.2 Theme 1: Pharmacy professionals' concerns and expectations regarding medication administration conducted by parents for children at home

When the respondents were asked to rate the most used dosage form for a paediatrics in their facility, among the extremely used dosage forms were oral suspensions (n = 23/38 (60.5%)), oral solution n = 21/38 (26.3%) and injections n = 17/38 (44.7%). These dosage forms were most consistently used or preferred due to different reasons, as indicated by the respondent. For oral solutions and suspensions, they were more frequently used because they are preferred by either the patient or the staff or they are easy to administer and/or for their tolerability and dose precision purposes. Injections were frequently used in critical care areas or for acute treatments and/or due to pharmacy professional preference in certain settings. Mini tablets were reported by n = 23 participants that they are not used at all, however, n = 12 reported that they are slightly used in their institution. Oral dispersible tablets were commonly used as reported by n= 10 participants. ***Table 3.2*** represents a summary of the response rate for each used dosage form among paediatrics.

Regarding the measurement tools dispensed along with liquid medications, n = 37/38 (97.4%) indicated that oral syringes are the most common tool dispensed. Respondents expressed that they are most commonly used because they can easily measure the dose accurately, and they are easy to use among small children while preventing any spillage. In addition to that, syringes are available in different volume sizes.

Participants were asked to list five chemical entities that are challenging to administer to paediatrics, and only n = 32 participants out of the 38 answered this question. In total n = 10 out of the 32 participants listed dispersible prednisolone tablets as one of the challenging medications to administer. Liquid omeprazole and flucloxacillin were mentioned by n = 5 out of the 32 respondents. n = 3/32 respondents stated that low molecular weight heparin injection was a challenging medication to be administered by parents at home, and n = 3/38 mentioned oral clindamycin as a formidable entity to administer due to its taste.

Table 3. 2: Response rate to the most used dosage forms for a paediatric patient in each of the respondent's facility

Questions	Responses	Respondents
1- Rate the most used dosage forms for a paediatric patient in your facility?		
a. Caplets	Not at all used	11 (28.9%)
	Slightly used	16 (42.1%)

Questions	Responses	Respondents
	Moderately used	6 (15.8%)
	Commonly used	5 (13.2%)
	Extremely used	0 (0%)
b. Capsules	Not at all used	0 (0%)
	Slightly used	13 (34.2%)
	Moderately used	19 (50%)
	Commonly used	6 (15.8%)
	Extremely used	0 (0%)
c. Creams	Not at all used	1 (2.6%)
	Slightly used	3 (7.9%)
	Moderately used	9 (23.7%)
	Commonly used	22 (57.9%)
	Extremely used	3 (7.9%)
d. Injections	Not at all used	0 (0%)
	Slightly used	2 (5.3%)
	Moderately used	1 (2.6%)
	Commonly used	18 (47.4%)
	Extremely used	17 (44.7%)
e. Mini tablets	Not at all used	23 (60.5%)
	Slightly used	12 (31.6%)
	Moderately used	3 (7.9%)
	Commonly used	0 (0%)
	Extremely used	0 (0%)
f. Ointments	Not at all used	1 (2.6%)
	Slightly used	4 (10.5%)
	Moderately used	8 (21.1%)
	Commonly used	22 (57.9%)
	Extremely used	3 (7.9%)
g. Oral dispersible tablets	Not at all used	1 (2.6%)
	Slightly used	10 (26.3%)
	Moderately used	11 (28.9%)
	Commonly used	10 (26.3%)

Questions	Responses	Respondents
	Extremely used	6 (15.8%)
h. Oral Solutions	Not at all used	0 (0%)
	Slightly used	0 (0%)
	Moderately used	1 (2.6%)
	Commonly used	16 (42.1%)
	Extremely used	21 (55.3%)
i. Suppositories	Not at all used	1 (2.6%)
	Slightly used	15 (39.5%)
	Moderately used	15 (39.5%)
	Commonly used	4 (10.5%)
	Extremely used	3 (7.9%)
j. Oral Suspensions	Not at all used	0 (0%)
	Slightly used	0 (0%)
	Moderately used	2 (5.3%)
	Commonly used	13 (34.2%)
	Extremely used	23 (60.5%)
k. Tablets	Not at all used	0 (0%)
	Slightly used	3 (7.9%)
	Moderately used	11 (28.9%)
	Commonly used	19 (50%)
	Extremely used	5 (13.2%)

From the respondents' perspective, parents were considered primarily responsible for ensuring that their children are receiving all of their medications. When the child's age is appropriate, participants strongly believe that parents should discuss the medication administration process with the child, this includes: why the child is taking this medication; the possible side effect of the medication; discuss different available dosage formulations; involve the child with the decision; explain when to take the prescribed medication; and the dose to be taken as well as for how long the duration of treatment is going to be.

Respondents were asked to indicate the most challenging age group to administer medication to:

- 15 (39.5%) participants considered that neonates (0 - 28 days) represent an extremely challenging age group among children.
- 19 (50%) expressed that infants aged 28 days to 6 years were second after neonates.
- 21 (55.3%) expressed that children aged 6 to 12 years are neither challenging nor challenging.
- 11 (28.9%) expressed that adolescents aged 12 to 18 years were not challenging, when it comes to medication administration if the timing of medication administration was incorporated within their daily routine.

Furthermore, 15 respondents gave reasons behind their chosen age group, among which 11 were for the choice behind neonates. The majority (n = 9) of the justifications were linked to formulation related reasons, such as the lack of suitable formulations, along with the drug volumes and insufficient available information to support the medication choice. Others (n = 2) indicated that medication administration techniques sometimes could be complicated for neonates.

Participants were asked about their common concerns per age group when a new medication has been prescribed. Results are summarised in ***(Table 3.3).***

Table 3. 3: List of concerns per age group by the pharmacy team when a new medication is prescribed

Child age group	**Common concerns by the pharmacy team**
Neonates (0-28) days	▪ **Dose, strength, and tool:** Volume and frequency of the dose, availability of dosing information and appropriate tool to measure the dose, dose adjustment as the age changes. ▪ **Medication:** the availability of licensed product, suitability of the product or the excipient, is there any interaction with milk, availability of the medication in community pharmacy with the same strength. . ▪ **Parents and caregivers:** does the parent(s) understand how and when to give the medication and if there is a dose adjustment. Parents not mixing the strength with the volume to be given. Safety issues, as most of the medication requires serial dilutions. ▪ **Pharmacokinetic and pharmacodynamics consideration**(e.g. mechanism of action, effect on the body, movement of the medication in the body)
Infants (28 days to 24 months)	▪ **Formulation:** availability, containing inappropriate excipients, taste, volume, suitability of preparation, ▪ **Dose:** the availability of dosing information, dose adjustment for long-term medications. ▪ **Parents and caregivers:** Do parents know when and how to give the medication, parents mixing up between volume and strength of the medication. ▪ **Compliance issues:** rejection by the child because of the taste, difficulty getting the infant to take medicine as behaviour changes with age.
Children (2 to 12 years)	▪ **Formulation:** Taste, suitability, availability. ▪ **Parents and caregivers:** do they know when and how to give the medication, do they know how to crush tablets, easy administration by the parents. ▪ **Compliance issues:** poor compliance because of the taste; scheduling with school, Ability to take/give medicines can become harder as kids can have more tantrums, etc., school/peer pressure, duplication of the supply as might need to give the school/nursery to administer.
Adolescents (12 to 18 years)	▪ **Formulation:** availability, suitability, preference (tablets or liquids). ▪ **Puberty**: change in body composition. ▪ **Adherence, Compliance and Patient acceptance**, transition issues and transferring responsibility from carer to patient. ▪ **Shared ownership:** they need to be educated on the medication given, If a chronic patient, then including the patient in more of the decision making than the parent (depends on level of maturity). Encouraging adolescent to engage with treatment and begin to take ownership in preparation for adulthood.

	▪ **Social considerations:** Medication administration at school where unavoidable and effect of stigma of this on compliance.

3.3.3 Theme 2: Pharmacy professionals' recommendations to support parents while administering medication to their children

Twenty one (55.3%) indicated that counselling time between pharmacists and the patient or parent is a priority measure that could help parents' understand how to administer medication correctly. Simultaneously, others (sixteen (42.1%)) specified that training and educational materials for patients or parents are a priority. Regarding Patient Information Leaflets (PILs), fifteen (39.5%) respondents ranked it as a second priority after counselling, indicating a need to tailor these leaflets to patients, parents, or caregivers.

In this survey, respondents were asked, from their clinical experience, what the main challenges are that parents face with medication administration to their children. The respondents (n = 15) reported that parents face various challenges, which include:

- The ability of the parents to understand the complex regimen prescribed (n = 6).
- Parents unable to understand administration information provided to them (n = 4).
- Ensuring that the child is taking the medication, especially for unpleasant-tasting medications (n = 2).

Respondents were asked how parents could be supported to help them to administer medication to their children accurately; the majority of the answers (n = 10) were related to providing better educational material, including redesigning Patient Information Leaflets, longer patient/parent counselling time, as well as to be able to demonstrate the volume of the medication to the parents and observe them to check accuracy. Finally, a few of the respondents (n = 4) recommended developing a national NHS phone application to parents and patients, particularly for commonly prescribed medication among children and young people. This guide should include instructions on how these medications need to be prepared and administered by parents.

3.4 Discussion

The sample recruited was from a different geographical background in the UK as well as outside the UK. Therefore, it gave an insightful perspective from a pharmacy professional into the concerns and challenges that parents experience while administering medication at home. Two main themes were identified from the survey. **Dosage form preference among this age group:** The respondents expressed that liquid dosage forms are most commonly used for various reasons (preference by the patient or the staff, easy to administer, tolerability and dose precision purposes), injections are also commonly used especially in critical care areas or acute treatment. **Measurement tool size that is the most commonly used:** the respondents indicated that oral syringes are the standard tool dispensed because they are easy to measure the dose accurately and easy to use among smaller children while preventing spillage, as well as they are available in different volume sizes. From the pharmacy team perspective, parents are considered primarily responsible for ensuring the child receives all of their medication. When the age of the child is appropriate, parents should discuss with the child the medication administration process.

The most extremely challenging age group to administer medication among children is neonates (0 to 28 days). That is due to the lack of suitable formulations, medication volume and insufficient information to support the medication choice. Pharmacy professionals indicated that counselling time is a critical factor that could help parents understand how to administer medication correctly. In addition to that, training and educational materials for patients and parents are a priority. From the respondent's clinical experience, they have listed the main challenges that parents face with medication administration to their children, among which are the ability of the parents to understand complex regimen and administration information provided to them, as well ensuring that the child takes the medication, especially for unpleasant-tasting medication.

To the best of my knowledge, this is the first survey looking at the pharmacist's perspective on the challenges for parents and young people with medication administration at home. From a pharmacist perspective, the findings of this survey indicated that neonates are the most challenging age group to administer medication to, followed by infants. This could be due to their small body weights that

make them vulnerable to medication errors; limited information about the medication prescribed compared with adults and older paediatrics; as well as, the rationale behind calculating/adjusting the dose; and the use of unlicensed medication for this age group. All to which contribute to a complex medication process including administration (Gray and Goldmann, 2004;O'Donnell et al., 2002). Pharmacists have various concerns per age group when a new medication is prescribed, which might be related to the medication itself, the parents' ability to understand medication instructions, especially complex regimes, compliance and other age-specific concerns. Previous studies have identified that parents failed to increase or decrease medication doses, or they did not translate the medication instructions correctly to other members at home. At the same time, another looked at new counselling strategies that could support parents' understanding of medication instructions at home. (Walsh et al., 2013) (Yin et al., 2008)

While pharmacy professionals strongly believe that parents play a crucial role in facilitating medication administration to their children at home, they have highlighted in this survey that there are limited resources available to parents and young people aiding them to administer medication accurately at home in the UK. The findings from this survey helped the research team establish a key points from a pharmacist team perspective about what concerns they have regrading medication administration among children at home, the information gathered form this survey aided in the design of the REMEDY study both phase one and two(Chapter 4 and 5). This finding further supports the current initiative that has been conducted by the medicines for children team. The medicine for children is an organisation run in partnership by three UK based organisations, Royal College of Paediatrics and Child Health (RCPCH), Neonatal and Paediatric Pharmacists Group (NPPG) and the charity Well child. This was set up with an aim to provide, parents or carers with information resources provided by the organisation's websites to access resources and information to support them with medication administration to their children (Medicines for Children, 2019)This group ensure to involve parents and carers in the design of the medication leaflets found on the website. Parents and carers get to test the website and give their opinion based on the experience with their child medicine on what kind of information is needed on the leaflet. Based on the increase demand and request from parents to provide a mobile application that included general and personalised

services regarding paediatric medication and their administration. The group mobilised an initiative to develop a mobile application. During the development process of this mobile application over 200 parents were consulted. The findings from this survey supported the need for resources that could help parents with the child medication administration at home. The research team where in contact with a member of the medicine for children team, and discussed the initial findings of the survey to further support the initiative by evidence based data. (Medicines for Children, 2019)

Although the survey captured the opinions, recommendations and practices of members of the NPPG group, consisting of currently working paediatric pharmacy staff from inside and outside the UK. Recruiting this specialist pharmacy group is a strength to this study, as pharmacy staff have a better handle on the issues regarding medication compared to other general healthcare professionals'. One of the limitations of this study is that it did not include pharmacists and other pharmacy team members outside the NPPG group, such as community pharmacists, technicians and dispensers. Furthermore, the study is subjected to some other limitation which is the response rate. Only 38 out of the 300 members of the NPPG completed the survey. Although the main reason behind this low response rate is the timing of the distribution of the survey that was sent out by the group secretary at the same time of the midterm (half-term) school holidays, this meant that many of the members were away from work and their e-mails, and upon return, the study invitation email was missed out by the members.

3.5 Conclusion

There are various medication administration related concerns from a pharmacist perspective when a new medication is prescribed. To optimise care at home, further investigations are required to highlight issues and concerns from a parent and young person perspective, and design resources to aid parents and young people in administering medication at home.

Chapter 4 – Realising the issue of medicine administration to the young (REMEDY): Phase one findings

4.1 Introduction

Medication errors frequently occur among children and young people at home, commonly at a medication administration stage, where parents are responsible for administering the medication to their children (American Society for Parenteral Enteral Nutrition, 2002).

In the USA, a multisite study was conducted to identify types of medical errors occurring in an outpatient paediatric clinic. The study identified 136 medical errors; 56 (38%) were medical treatment errors, among which 47 (84%) errors were related to medications (Weiss et al., 2005).

In 2007, another USA based prospective cohort study, involving 1788 paediatric patients, was conducted in six different paediatric outpatient clinics. The research aimed to measure the rate and type of adverse drug events. In total, 283 errors were identified accounting for 16% of children treated at the selected sites; where 57 (3%) adverse drug events were preventable, and 40 (70%) of the reported incidents were related to parental administration errors (Khazaezadeh et al., 2012). Overall, the study highlighted the importance of clear communication between healthcare professionals and parents and its drastic effect in reducing preventable medication errors.

Few studies have discussed medication-related incidences among children at home (Yin et al., 2010). In an observational study carried out in the USA over six months, 52 homes were visited, and 280 prescriptions were reviewed (David August, 2002;Walsh et al., 2011b). Sixty-one medication errors were identified, among which 31 errors could potentially cause injuries, and nine errors did cause an injury to the child (Walsh et al., 2011b). Communication barriers were reported to be the main reason behind those errors. In 25/280 (15%) of the cases, there was even miscommunication between the two parents; this resulted in medication administration errors.

A USA based study investigated the type of medication errors encountered among children younger than 18 years old who were diagnosed with depression. The study reported 451 medication errors and most of the errors (33%) were identified at the medication administration point (Rinke et al., 2010).

Another study assessed parents and caregivers understanding of the age indicated on over-the-counter (OTC) cold and flu medications` labels (Yin et al., 2014a). Results from this study revealed that low levels of parental health literacy increase the risk of misinterpretation of OTC products intended for children. This is further influenced by the language, pictures and labels used on the product; resulting in medication errors and in particular administration and dosing errors (Yin et al., 2014a).

To our knowledge, so far, there have been no published studies regarding the challenges and issues of medication administration among children and young people in the UK, from both parents' and children`s and young persons' perspectives. Hence, this study was set up to address whether there is a current issue regarding medication administration among children and young people at home, and to highlight the nature of any problems and challenges. To understand the issues and challenges a mixed-method two-phase study involving both parents of children and young people was conducted.

4.2 Aims and Objectives

This study aimed at identifying via interviews the specific problems and challenges of medication administration that occur among children and young people at home, from a parent`s or patient`s perspective.

To achieve this project`s overall aim, one-to-one semi-structured interviews were conducted with parents who were currently responsible for administering medication to their children aged 0 to 18 years old. In addition to parents, young people aged between 16 to 18 years old were also interviewed, to understand the nature of medication administration challenges and issues occurring at home from their perspective.

4.3 Methods

4.3.1 Ethical approvals

The feasibility and applicability of the study methodology was peer-reviewed and assessed by leading experts (JA, J C-W) in the field of paediatrics in the UK and by the research team who are experts in conducting patient-centred research projects. Furthermore, Health Research Authority approval was granted by the West Midlands - Black Country Research Ethics Committee in June 2019 ref: 19/WM/0142 protocol no. 273-2018-DD, IRAS project ID 258491. ***(See appendix D for the submitted IRAS application).***

4.3.2 Study type

This was a mixed-method two-phase study conducted in four paediatric hospitals and one university in the UK. This chapter describes the findings from phase one. In phase one, parents and young people were interviewed using a semi-structured interview guide.

4.3.3 Inclusion criteria and recruitment strategy

The study`s participants were English-speaking parents of children aged between 0 to 18 years old and English-speaking young people aged between 16 to 18 years old. Eligible participants were the primary caregiver or patient who is responsible for administering the medication at home. For the purposes of this chapter, both parents and informal caregivers are referred to as parents.

The study team designed and tested five participant information sheets (PIS), one for parents and informal caregivers; one intended for young people aged 16 to 18 years old; one for the age group of 11 to 15 years old; one for the age group of 6 to 10 years old; and finally, one for children aged below 5 years. It was crucial for the team to address the research question with all potential participants and allow children to express their approval for their parents to discuss their problems with the research team. Hence, each information sheet was age-appropriately designed to accommodate the age difference that have been targeted in this study. ***(Appendix E to H displays all the study`s PIS)***

In each hospital, an assigned local collaborator worked with the principal investigator (PI) to identify and approach participants for recruitment. The local collaborator provided the participant with the age-appropriate participant information sheet (PIS) and the interview guide. Once an initial interest was expressed by the participant, the PI of the study approached the participant, further assessed their eligibility to the study, clarified the aim of the study and allowed time for any questions before informed written consent and/or an assent form was obtained. ***(See Appendix I to K for the assent form and consent forms.)***

Recruitment at the educational site within the West Midlands was done through invitations to the University staff and students via their official Aston University email. Once a participant showed interest, they were asked to email (DD) the principal investigator via email. Further information such as the participant information sheet and the interview guide were provided to the potential participant. ***(Appendix L is the invitation letter for Site E.)***

The interviews were conducted by the principal investigator (DD) who underwent training on conducting semi-structured interviews in 2019, on good clinical practice (GCP) and on obtaining consent.

4.3.4 Research settings

In total, five sites were involved in this study. Included participants were parents or young people who attended one of these four NHS children's hospitals: children`s hospital in Liverpool (North West England-Site A); the children`s hospital in Birmingham (West Midlands-Site B); and two children hospitals in London (South East-Site C and Central London-Site D); as well as staff and students of an educational institution in the West Midlands (Site E).

4.3.5 Interview guide

The semi-structured interviews that were conducted in the hospitals took place in an outpatient pharmacy`s consultation rooms and on the wards as well as care clinics; while the interviews that took place at the educational institution were conducted in a pre-booked private meeting room. All the interviews were conducted across England between August 2019 and January 2020.

The semi-structured interview guide included questions about parents' and young people's personal experiences and challenges, with regards to administering or taking medication at home. Parents and young people were asked to provide recommendations that could help them to be more confident when administering or taking medication at home. ***(See Appendix M for the interview guide for both parents and young people.)***

The health literacy for each participant was assessed during the first 7 minutes of the interview, using the standardised modified version of the Newest Vital Sign tool (NVS) (Weiss et al., 2005). This tool has been modified and validated against previously validated tools to measure health literacy in the United Kingdom (UK) (Khazaezadeh et al., 2012). The modified NVS was opted for as it is a reflection of an everyday activity which helps to reduce any potential test-related anxiety. Additionally, it is a simple and short comprehensive tool designed to measure numeracy and literacy skills that are crucial for the interpretation of medical instructions. In addition to that, this tool is valid for any epidemiological surveys and clinical trials (Rowlands et al., 2013). ***(See Appendix N for the NVT used to access participants' heath literacy levels.)***

The assessment included six nutrition-related questions, and each question was awarded with one point. The participant would be deemed to have an adequate literacy if they answered 4 to 6 questions correctly; possible limited literacy if 2 to 3 questions were answered correctly; and a high likelihood of limited literacy if they got 1 to 0 answers correct (Yin et al., 2010).

4.3.6 Data management and analysis

An inductive (data-driven) qualitative thematic analysis based on Braun and Clark's method was used to identify the current challenges and issues of medication administration at home from parents' and young people's perspectives (Braun and Clarke, 2006). The interviews were recorded on an encrypted digital audio device which was transcribed verbatim, checked, and any identifiable information was removed. The combination of both the recordings and the PI's notes ensured the reliability and validity of the transcribed data. The author (DD) coded and generated the initial themes. All the research team (CH, DT, DK) checked and defined the final themes of the study.

4.4 Results

Enrolment took place from August 2019 to January 2020. Of the eligible parents and young people, 49 participants were enrolled and included in the analysis of this study across five sites. The study's subjects were primarily parents, numbering 46 (93.9%); and 3 (6.1%) were young people aged between 16 and 18 years old. There were 36/46 (78.3%) female and 10/46 (21.7%) male parents. There were 2/3 (66.7%) females and 1/3 (33.3%) male young patients aged between 16 and 18 years of age.

Almost half of the participants had adequate literacy levels, scoring between 4 to 6 on the NVS test. Then 45% of the sample scored between 2 to 3 on the literacy test indicating that they might have a limited literacy level; and a minority (8.1%) scored between 0 and 1, indicating a high likelihood (50% or more) of limited literacy levels. ***Table 4.1*** describes the participants in this study.

Table 4. 1: Participants' Demographical Characteristics

Characteristics	**Total% (n =)**
Setting (City)	
Site A- Children Hospital (Liverpool, North West)	24.5% (n = 12)
Site B- Children`s Hospital (Birmingham, West Midlands)	24.5% (n = 12)
Site C-Children`s Hospital (London, Central)	14.3% (n = 7)
Site D- Children's Hospital (London, South East)	26.5% (n = 13)
Site E- Educational Institution (Birmingham, West Midlands)	10.2% (n = 5)
Gender	
Female	78.3% (n = 36/46)
Male	21.7% (n = 10/46)
Female (young person - the patient aged between 16 to 18 years)	66.7% (n = 2/3)
Male (young person - the patient aged between 16 to 18 years)	33.3% (n = 1/3)
Literacy Level	
Adequate health literacy	47% (n = 23)
Possibility of limited literacy	44.9% (n = 22)
High likelihood (50% or more) of limited literacy	8.1% (n = 4)

Thirty seven (80.4%) of the participants explicitly expressed that they are either currently or previously experiencing issues with medication administration at home. While nine (19.6%) participants experienced no problem but expressed some concerns and challenges with the administration of medication at home. Findings were categorised into three themes ***(see Table 4.2 for themes identified from the interviews)***.

Participants reported many challenges related to the medication itself, which included the taste, the complexity of the dose preparation and the texture of the medication. There were also challenges regarding medication administration instructions provided with the medication describing how to give the medication at home. However, participants who encountered issues in medication administration at home implemented techniques that helped them overcome any encountered issues.

The challenges and recommendations by parents are described in more details below, along with representative interview quotes within the results section.

Table 4. 2: Summary of the identified themes for phase one REMEDY (interviews)

Theme Number	Details about the main theme	Subthemes for the main theme
1	Medication administration challenges at home from a parental and young people perspective	▪ Problems related to medications – dosage form characteristics preference. ▪ Other associated challenges with medication administration – information and instructions of how to administer a paediatric medication dosage form.
2	Parents and medication experience of interpreting medication label instruction and their preference	No subtheme emerged from analysing the interviews.
3	Recommendations for safer medication administration at home based on a parental experience perspective	▪ Flavour masking ▪ Smaller increments on syringes and limiting the amount of syringes required to draw up a dose ▪ Fitted adapters ▪ Provide more instructions ▪ How to hold baby when giving medication

4.4.1 Main theme 1: - Medication administration challenges at home from a parental and young people's perspective

This theme included problems related to the prescribed medication itself and other associated medication administration challenges.

4.4.1.1 Problems related to medications – dosage form, characteristics preference

Parents and young people reported they had issues with the prescribed medication; these issues were linked to either patient preference or some other specific challenges associated with the child`s health issue.

In regards to children and dosage form preferences, parents expressed that they struggled when tablets are prescribed instead of liquids, as their children preferred taking liquids to tablets. This preference was stated not only by parents with children aged below 15 years old, but also included younger people aged 16 years. Although liquids are preferable by children, they also come with a set of challenges such as taste and texture.

P13 from Site A Said: "Tablets, she hates taking tablets so, only because of the process of actually taking the tablet, so if you can break it that resolves the issue but then her perception is that she's gone from having two to she's now having four and she never wanted one in the first place so!" **(Parent expressing that issues she faces when tablets are prescribed to her child)**

P39 from Site B Said: *"I've got four, so there's a 6, 10 year old, 15 and 16. The 16 year old refuses to take tablets."*(Participant expressed that even her 16 years old child prefers liquid formulation)

The taste of the medication was one of the challenges that parents struggled with. Parents reported having to use a lot of persuading techniques with their children to administer a medication with an unpleasant taste. In some cases, parents reported they might administer more of the liquid medication to ensure the full volume has been administered, which further stresses the parent because they are not sure if they did it correctly. When it comes to the most commonly problematic medication reported by parents, antibiotics are among these medications that parents struggle to administer at home, because of the taste issue.

P12 from Site D Said: "Challenges, yes, if it's a liquid, like an antibiotics, in a liquid form, usually they don't want to take it because it tastes horrible." **(Parents find liquid antibiotics are challenging to administer due to unpleasant taste).**

P34 from Site E Said: "I have some problems giving to her because my daughter is young and sometimes it's not easier for her to take it, she doesn't like the flavour or, so that's why it's a little bit more complicated. It takes longer and sometimes she's not taking all the medication in, so sometimes you have to add a little bit more. Well, you'll always worry if it's enough or if it's okay." **(Parent expressing that due to taste, she find administering medication challenging and she often give more medication to ensure accurate dose volume was given, but she become worried what she did is correct or not).**

P35 from Site B: "She doesn't like medication. I think it's like, there are some flavours of the medication she prefers like the strawberry, red one. She has sickle cell; she takes Ampicillin every day, morning and evening. So any time we go to the pharmacy, ask them, we want the strawberry flavour. She don't like the orange one or the plain colour one. "**(Parent ensures to get the strawberry flavoured Ampicillin from the pharmacy, as her daughter prefers it over other flavoured liquids)**

P35 from Site B: "It's only the flavours. Yeah, when we can have that, that is our choice. Otherwise the other one is like, taking it is a big fight, I will tell her I'm going to take you back to the doctor, they're going to give it you if you don't take your medication, then she will take it." **(Parents expressed that liquids needs to be favoured, if none flavoured liquid was provided a lot of persuasion is required to administer the dose)**

P40 from Site B: "The fact that they're scared of taking the medication because they don't know if they're going to like the taste of it or what the effect of it is going to be." **(Parents expressed that his children are afraid to take medication just because they might not like the taste of the medication)**

P41 from Site B: "I would say probably the flavour of them, so being able to get them to have the medicine. So stuff like Calpol, which is I guess the one that you have all the time, that's flavoured

okay so they're fine with that but if it's any sort of antibiotics it's generally difficult to get it into them." **(Parents find it difficult to administer antibiotics, due to flavour)**

P33 from Site B: "the only thing I think that's the problem is the texture of some medications. So like Ciprofloxacin is quite squidgy, she does not like. No, so sometimes they'll be actually like little balls of grit inside them, so I think that, that can be a problem, and especially if they're quite young it's quite, it's sort of like, will make them gag." **(Participant child struggles with the texture of the medication)**

Some concerns were highlighted in regards to crushing tablets. Parents expressed that having a medication that required crushing could be inconvenient and time-consuming, mostly if it's done more than once a day. Parents also mentioned that more information about how to prepare the dose is needed, such as how to crush a tablet and how much water needs to be added to dissolve a tablet. Parents expressed that knowing the answers to these questions will provide them with confidence with preparing the medication and administering the dose correctly.

P24 from Site D: "well I had to crush it because she wouldn't take tablets to start with, so they said it has to be crushed and dissolved in the water. Yeah, my daughter has seizures and she's on Sodium Valproate, the liquid and the Clobazam and that's tablets and then you have to crush it and the first time I took it home that tablet and I didn't know how much water to put because it wasn't saying on the instructions." **(Parent was not sure of how much water on the tablet is needed as it was not written on the provided instructions)**

P36 from Site B: "Some of the tablets are not soluble so we have to grind them, really fine, put them in water, make sure that there's like, they're all dissolved …It's not a struggle it's just, it's inconvenient. Having to like grind it first. Yes, and then like you have to wait for it, put it in the syringe with the water and wait for it to like dissolve…. Like and if you're out and about and you only, it can only sit in the syringe for an hour. So if you're out and about you've got to rush back to give her medication, sort of like inconvenient. Twice, twice a day. Yes, we have to take it with us like to people's houses and you know." **(Crushing a tablet sometime might be inconvenient for parents)**

P38 from Site B : "Yeah. When I start the medication crush the medicine and put it in yoghurt or something, like on the spoon and give it to her all in one. So when I crush it I think I left some in the pot, I can't, obviously I can't give her all of the medicine. So yeah, that's struggle. I will think that my daughter had full medicine. So now I start to give her the full, the medicine with the water and it's struggle. Sometimes she just have one sip and swallow, sometimes it can scare her she might get stuck or something. She's so petite as well, you know, yeah, but she didn't eat it." **(Crushing tables leave this parent with some uncertainties in regards to whether what she gave her child is correct dose or not)**

P16 from Site A: "Yeah, so you just take 2ml of water, open the capsule, dissolve it, and then obviously take out whatever the dose is that you give to the baby, in her case 1.3mls and then she just has it like that, so it's not hard to make, it's not, I don't know, a struggle, it's just time consuming, it's just an added thing three times a day." **(Parents find crushing tables is time consuming especially when it's given more than once a day)**

4.4.1.2 Other associated challenges with medication administration – information and instructions of how to administer a paediatric medication dosage form

Medication administration instructions are a commonly reported issue by nearly all recruited participants. Parents and patients have expressed that either not enough information was provided with the prescribed medication or unclear instructions were given to the participants, and receiving different administration instruction labels from other institutions made them sometimes confused. Consequently, some parents had to look up information from online resources that might not be reliable or related to the patient's case; which further raised some more questions and queries by the parent regarding the medication they administered to their child.

P15 from Site A: "I think the worst challenge last week, to give him, what is it, Methotrexate. I wasn't, I had to Google what I was giving him, I've read up on it. But actually, after I give him it, I wasn't, I was not liking myself very much for giving him it. Because of the side-effects which occurred, which I wasn't told about. So, you know, therefore I was sobbing, I was crying. You know, I really didn't want to put a medicine in my son which I didn't know much about but I just trust the

doctors and nurses when they say it'll be fine. So I'd like, next time, to be told a bit more of the side-effects and possibilities, what can happen at home. So next time, I'd like to be made more aware." **(The parent was so stressed after giving her child Methotrexate. Due to not having enough information provided, the participant had to look up for information about the medication online, which put her under very stressful situation and question her decision to allow her child to take this medication)**

P25 from Site D: "And also I had to go back to another pharmacy because it says you have to take the medication 2 hours after food or 1 hour before food, which made me a bit confused, you can't starve a child for like 3 hours. I went to a pharmacy and asked them and they said oh, ignore the 2 hours bit just give it 1 hour before food."**(The parent had to seek further professional advice in regards to medication administration and food)**

P9 from Site C: "This is going to sound odd, so because my daughter has a condition I look on social media with people with the same condition as X, that's where you find the difference. Because you'll come across a medication that you've been on for years and then someone will make a comment about that you cannot take dairy products within 2 hours of this medicine, but you didn't know that if you know what I mean, you know, and then that sometimes causes you to look it up again and that sort of thing." **(Parent found information about her daughter medication online that she did not know about before, but that might not be similar to her child health circumstances)**

P8 from Site C: "Yeah you get taught how to do meds but you get, there are loads of different types of meds, the labels are different. If we get them from here they're different to if we get them from our local hospital, in South London King's, and then the community pharmacy A there, and then if we get them ourselves via the GP prescription and then picking up from Pharmacy B and Sainsbury's or whatever, that again will have a different label and they will have different, they'll have different, they'll have different text and different stuff bold, emboldened."**(Different medication labels from different healthcare provider that could confuses the parents when administering the medication)**

There were some reported administration challenges that were related to the child's age; especially infants and toddlers, as well as the difficulties that are related to the child's health condition. Parents also expressed that they fear that they are not administering the medication to their children accurately, which further puts them under pressure.

P29 from Site D: "I guess it's just always making sure the dose is correct, making sure I'm not overdosing. One of the issues I have in particular is both my boys are quite big, so it's always been a bit questionable for me because everything is age related on the sides of medications, but I'm conscious that actually it would be more about their body mass, but so I've always stuck to kind of age related dosages, so as not to overdose, but I kind of never really know whether I'm giving the right amount if I'm honest."**(Parent is unsure if they are administering the dose correctly)**

P10 from Site D : "Sometimes we do because my daughter does, rather anti-oral, she'd have a strong gag reflex to anything, however, that's getting better now, we've found a lot of the medicines they have spoons rather than syringes, so it made it a bit difficult to administer." **(Child health condition and measurement tool used)**

P45 from Site E: "For my son he is allergic to nuts so I always double-check the ingredients list to make sure it is suitable for him, and he also suffers at times with asthma, so I also read, check the labelling for any notifications about asthma." **(Child health condition)**

P44 from Site B: "Because he's got behavioural issues it's hard to get him to take it. So I have to restrain him to give it him really." **(Child resistance pause an issue to administer medication)**

Table 4. 3: Key summary issues of medication administration challenges among children and young people as reported by the recruited participants

Medication administration issues at home from parents and young people perspective	**Dosage Form Related Problems** Parents and young people generally prefer liquids over tablets. - Liquids Related Issues (Taste and Texture) - Tablets Related Issues (Crushing)
	Medication administration instructions related issues Parents expressed that clarity in information provided, as well as standardised administration instructions are needed.
	There are administraton challenges related to the child Age and Health.

4.4.2 Main theme 2: - Parents and medication, experience of interpreting medication label's instructions and their preferences

When participants were asked about the source of instructions that they rely on when they prepare to administer the medication at home, the majority of the participants (n = 19/49) responded that they would administer the medication according to the doctors' instruction; while others (n = 13/49) will administer according to the labels printed on the medication box. Few (n = 9/49) will depend on the pharmacist to explain how and when to give or take the medication. A minority of the participants (n = 5/49) highlighted that they would crosscheck the administration instructions' accuracy across all sources of instructions. Although some (n = 4/49) of the participants will still read the leaflet provided in the box of the medication, however, they will not necessarily use it to find out the dose, they will look for information with regards to side effects from administering the medication to their child.

P6 from Site C: "But generally going by the doctor's advice and occasionally sort of read the labels to remind yourself if it's a new one what to take. But, yeah, I tend to sort of, rather than read the labels, would go with what the doctor's advice." **(Parent goes with the doctor`s Advice)**

P41 from Site B: "I guess you don't get that much instruction from the doctor, as silly as that sounds. They kind of say "look we're going to give you this medicine" and then it is all printed on the

prescription. They must run through it with you but I guess the last port of call is the pharmacy. So yeah, kind of rely on that I would say personally." **(Parent goes with the pharmacist instructions)**

P2 from Site E: "I always check with the label, even if I remember the volume to give her I still check the label, just to be sure. And usually the label is the same as the doctor's advice, yeah." **(Parent goes with the label instructions)**

P1 from Site D: "I always try to go with what the doctor's saying, but it can happen that the doctor's spoke to you, and as soon as you leave the, as soon as you get the medicine you don't remember half of what they say sometimes. So if they don't explain to you again at the pharmacy I'll just check the notes and the leaflet and everything is there really. The labels, oh yeah, sorry, the label as well, because the label has his name, it has how many times he has to take it a day, it has the dose he needs to take as well, so yes, if he has, if it has a label first. The label, and then if it's not specific just go to the leaflet."**(Parent crosscheck all sources of instructions)**

P17 from Site A : "I can have a look at the leaflets, but leaflets is just not necessarily for the dosage of what you need, it just describes what is there, so we would contact our nurses, nurse practitioners, and then they will come back to us and then they'll explain how it needs to be done." **(Parent reads the label for information about side effects)**

4.4.3 Main theme 3: - Recommendations for safer medication administration at home based on a parental experience perspective

When participants were asked for, recommendations that need to be in place for them to be more confident when administering or taking medication, the recommendations mainly concerned on the following:

-Instructions and administration information provided

- Optimising the taste of children's medications

-Measuring tools for liquid medications

In regards to the taste of the medication, participants (n = 4) suggested that they wish to have different flavours for the same medication; this also included the option of having a tasteless medication.

P1 from Site D: "A medication, a tasteless medication. Just like water." **(Tasteless medication)**

P35 from Site B : "so if they would be able to provide you know, as much flavours as possible so that everyone can get whatever they want. Because with kids, it is hard to force them to take medication. You don't want to see that sad face in them. Yeah, if any time we don't have the strawberry one, most of the time her sister is doing it because I just don't like the look, you know." **(Strawberry flavoured medication)**

P41 from Site B: "I'd say it was just the flavouring. As stupid as that sounds I think that's it. I think because it's different if it's just Calpol or something, it's not as important, but I guess if it's antibiotics and they could really do with it, then making sure they actually get the dosage that they need would be easier if they're going to swallow it. But yeah." **(Nice flavoured medications)**

For the measuring tools provided with liquid medications, the main suggestion was to have smaller increments on the syringes that could help the parent be more precise when preparing for fractioned doses or smaller doses. Also suggested was the provision of an adapter that is manufacturer prefixed in the liquid bottles, and not those which are provided separately where parents are required to attach them. Some parents recommended that it's safer from their experience, if the pharmacist dispenses a syringe that matches the dose prescribed; this will help reassure parents that this is suitable to prepare the right dose (amount).

P10 from Site D: "Maybe supply both a spoon and a syringe with a fine measuring gauge on. Like half a ml, so a lot of the measurements are like 0.6mls, so if they were like 0.2ml measurements they'd be easy just to draw out, you know, finer measurements. Yeah, a lot of them do it, Omeprazole, no, sorry, Levothyroxine, comes with a small 5ml syringe with 1ml increments, so That's easier to work out the measurements." **(Parent recommended smaller increments on the syringes)**

P11 from Site D: "The adaptor that you put in it, and the adaptor doesn't really stay in, it doesn't really secure in and I don't know whether it's because it's not for that bottle, or it's just a universal

adaptor that goes onto all bottles so when I turn the bottle upside-down it will still slide out a little bit" "It would sometimes leak out a little bit, but so when the bottle is coming to an end but there's still medicine in there it's quite hard to get the medication out, do you know what I mean?" "Like Calpol, that'd be quite good actually, so then you can just stick it in, it doesn't come out, if you turn the bottle upside-down it's stuck in, can't leak. But with the bottles like these ones that you've to put it in and then yes it doesn't really stay in properly, and that's what I'm, I wouldn't say struggling, I mean it would just be a bit more handy if it was like the Calpol bottle definitely, but yeah, that's it." **(Parent suggested a fitted adaptor)**

P47 from Site E : "That we'd use, as close to that, but anything where that you'd want the numbers to be clear, you know, try and take away the confusion that, you know, is it a 5 or is it a 10ml syringe, by issuing the right syringe it almost limits the problems that you can have, that's the only thing that I'd suggest. If you're going to be, say it only needs 2.5ml solution, well don't issue a 5ml because you're almost allowing the problem to happen, if it's only ever going to be 2.5 then only issue a 2.5 syringe, if it's going to be 5 don't issue a 10ml syringe, them sort of things, that's the only thing I think as a parent. And then basically that, and awareness basically, the clearer the syringe itself, the more simple the syringe itself the safer it is, because it, there's just, I can understand why some parents on occasion might overdose for example, or even underdose." **(Parent suggesting limiting the number of dispensed syringes and matching the syringe to the dose)**

Counselling and instructions were mentioned by the participants quite often during the interviews. Participants suggested having a health care professional provisionally demonstrating how to prepare the medication, especially for liquid medications, which could give them confidence when doing it alone at home. In addition to that, participants suggested having more information on holding a child while administering the medication, more verbal information from the healthcare professional about the prescribed medication, and providing some tips on how the taste of the medication could be masked.

P22 from Site A: "I just think more information, I understand that particularly here the doctors and nurses are extremely busy but they just say, he's going to be going on this, whatever it is and then

pick it up from your pharmacy, they don't give you any instructions and I'm the type of parent who wants to know the ins and outs of everything. I have before now rang up the pharmacy here just to clarify. No, they did tell me but then I was thinking, well is he likely to experience more side-effects with this or because the dosage has gone from 25, he's now on 100, not knowing really what to expect, you can read the leaflet but it is quite general, I mean, okay, it will tell you 1 in 10 will experience this, 1 in 100 but I don't know. Yeah, I mean even... You know, his medication is powerful so, you know, there's a worry and a bit of anxiety to it, so I just want as much information as possible from somebody in authority who can reassure as well rather than me reading this leaflet which." **(Provide more administration instructions)**

P33 from Site B: "I think it would be nice to be, for parents to be offered a bit of advice in regards to holding their children. The best way of administering, so eventually with the oral medicines don't try and squirt it directly into their mouth, down the cheek is probably a bit better, they'll swallow it, you know, just that kind of thing, because a lot of parents Anyone to be honest, any health professional that sort of adminis… dispensing the medicine essentially. Maybe just ask the question, are you confident to give the medicine, would you like, you know, we can talk to you about how to, because you'll have first time parents that just don't like, know what to do, and then you'll end with children that are really poorly, because they haven't had the medicine because they can't get it." **(Parent suggested they needed more advice on how to hold a baby when administering a medication).**

P14 from Site A: "I would say either, like give directions on how to take medication, like if you have this tablet for example, take it with something to balance out the taste, so you don't taste it, it's like tips on top of that."**(Patient suggested to provide more information on how to mask the taste of medications)**

4.5 Discussion

Our qualitative phase has captured an overview of the medication administration challenges that parents reported they experienced when administering medicines to their children, and the challenges presented to young people when taking medication at home.

The study documented a few challenges. Among these is the palatability and formulation of the medication prescribed, which can have a drastic impact on a child's adherence to taking the medication and could result in treatment failure as well as development of antibiotic/antimicrobial resistance. In a taste test study which enrolled children of 6 years old, they found that palatability is one reason for noncompliance among children, consistent with our findings (Angelilli et al., 2000). Similarly, in another review looking at adherence and the palatability effect, the importance of involving parents, children and practitioners around the decision prescribing the most suitable palatable formulation to ensure the successful administration of a course of treatment as well as adherence were emphasised (Baguley et al., 2012).

As a result of an unpleasant medication taste, parents often have to increase the volume of the administered medication to ensure that they have given a full dose to their children. In contrast, others will re-administer the dose if the child ends up spitting out the medication. This puts the parents under pressure, questioning whether they have administered the right amount of medication that is needed to clinically improve their child's health, or that they unintentionally gave more than what was needed (LI et al., 2000). On the contrary, some parents did not find that the taste of the medication was an issue; however, they have expressed that it would still have been beneficial for them to have guidance from a health care professional on how to mask the unpleasant taste of medication safely.

In addition to liquid related issues, parents reported issues related to tablets, particularly the process of crushing or grinding a tablet to be administered to their children. Parents at home often find it time-consuming and find themselves in need of more instructions on how to prepare medication for administration accurately.

Although parents expressed in this study that they mainly rely on the doctor`s verbal instructions and would possibly check the labels printed on the medication bottles, especially when the medication is being administered for the first time, relying on one type of instructions over another could be an issue. This was previously highlighted in one prospective observational study looking at medication errors at home. They found that sometimes parents who rely only on doctors' instructions, fail to adjust the child's dose as instructed by the doctor or they could miscommunicate the doctor's instruction to other caregivers at home (Walsh et al., 2013). On the contrary, for parents who rely on the label's instructions only, problem occur sometimes when the child's dose has changed, and the medication label does not reflect the current new dose to be administered. This further attributes to the child's medical outcome if they continue to administer the dose by what is written on the label(Walsh et al., 2013). Hence, parents and young children would benefit from a combination of sufficient verbal instructions from the prescriber as well as standardised written instructions using clear and simple language alongside, this to ensure that parents and young people understand medication instructions. This finding is consistent with previous work (Wolf et al., 2007).

The study highlighted some key information to be discussed with parents and young people during counselling time. This includes: the amount of the dose; when it id to be administered in terms of time and frequency; should it be given with or without food, information in regards to possible side effects; how to prepare the dose if crushing a tablet is prescribed; demonstrating the volume on the measuring tool if a liquid medication is provided; as well as checking whether the person who is administering the medication could actually do it correctly.

Parents recommended that a provisional dose demonstration on how to administer the medication as part of the counselling by a healthcare professional would make them more confident while administering medication to their children at home. To demonstrate how to use the measurement tool along with advance counselling has been proven by other studies to be an effective strategy in reducing medication errors (Yin et al., 2014a;Yin et al., 2007) (Yin et al., 2017). Other parents with young children aged between 0 and 2 years suggested having information and training on how to hold their baby while administering the medication.

When a liquid medication is prescribed, in particular if the volume of the dose is very small, parents struggle with measuring tools. When a dose is very little, the parents feel that the child is not taking anything at all, and they believe that the dose is still in the measuring tool. This finding is consistent with another study, where they found significant dosing errors were made with smaller dosage volume in comparison to larger ones (Yin et al., 2016). Others noted that when a fractioned dose is prescribed, they found it very challenging to measure it out, and as a result, they suggested half a ml incremental measuring tool. Parents also suggested that when a liquid medication is prescribed an appropriate measuring size tool could be provided, as often they find it confusing when the measuring tool does not match the prescribed volume. This is consistent with other findings that proved matching the tool with the prescribed dose can have the greatest impact on reducing paediatric dosing errors (Yin et al., 2017).

The study showed that parents do experience challenges when it comes to medication administration at home. These challenges vary between parents and across different sites. Parents and young people showed that a positive impact on medication adherence was seen when a personalised treatment plan involving the parents and the child was in place. This will help address any concerns that the family encounter with the medication and provide a sufficient time to discuss the child`s appropriate treatment. Parents suggested that the pharmaceutical industry might need to consult parents and children about formulation preference and how to design medication to be user friendly. The findings also have critical clinical implications in regards to counselling. Medication administration counselling is insufficient, and further work is needed to improve it. Although producing a paediatric formulation possesses unique challenges, there is a high demand from a parental perspective to provide a child-friendly preparation that takes into account the taste, formulations and volume required. Having medications with these requirements could potentially help parents to administer medication safely and accurately at home.

The study findings are unique because it is the first study that highlighted medication administration challenges occurring at home among children aged between 0 to 18 years old in the UK from a parent's/carer's and young person's perspective (patient-centred approach). This study helped identify the key issues among this age group that could be tackled to ensure medication optimisation

at home. Participant recruitment was stopped after theoretical data saturation was reached, where similar information was provided by the parents and patients. Our study has been conducted in five sites at three geographical locations that are spread across England. The findings were almost consistent across the sites, which make our study considerably generalizable in other children's hospitals within the UK. Furthermore, having different study sites gave a broader insight into the issue and the need for future research to address specific challenges per disease per age group especially for younger people aged between 16 to 18 years old. This study is subjected to the following limitations: selection bias, as only English-speaking parents and young people were selected to take part in the study, hence, the findings would only be applicable to English speaking parents and young people. Another limitation potentially could be reporting and recall bias, as we were asking parents/caregivers and patients to recall events of problems, so the study may only have received the most significant or memorable problems with regards to medicines administration. Another limitation is that the findings are applicable to health and home settings in England only, and may not be applicable internationally.

Qualitative research could be subjected to bias in relation to the influence of the researcher (DD), who is a pharmacist, parent as well as researcher. This research would have been closely related or influenced to what the researcher (DD) saw during their experience and years of practice in pharmacy, as well their experience of challenges to medication administration when they administer medication to their children. In order to ensure rigor and good quality of this research work, reflexivity was articulated throughout the planning process of this project as it's a gold standard for determining trustworthiness of qualitative work. (Teh and Lek, 2018) The researcher DD worked to mitigate this bias to ensure integrity and rigor of the project by using evidence based literature to inform the project findings. Since the beginning of the whole project and starting from designing the study protocol, a team consisted of academics and clinicians with leading experience and expertise in the area of pharmacy practice and pharmaceutics were involved, all working closely to ensure applicability of the project in real practice. A rational and evidence based methodological and analytical approaches were applied in the project. This include the data collection tools for both phases that had been designed and piloted among parents and young people prior to commencing

with the project, to ensure that every participants were interviewed in a consistent manner and to reduce any influence from the researcher (DD) influencing the outcome/findings. Furthermore, once the protocol was finalised and approved by the internal and external team, the protocol was shared with the Aston University research office and underwent an extensive review to ensure that there was value and integrity in the project. This included assurances that an age appropriate patient information leaflets were designed as well as consent forms. Throughout the data collection period, the key findings were shared with the research team and collaborators, as well as 30% of the interviews were revised by an expert in semi-structured interviews to ensure that the findings were not influenced by the researcher (DD) .(Buetow, 2019) However, with the researcher (DD) being a parent, pharmacist and researcher, this may have on the contrary enriched the project findings positively and provided a deeper contextual understanding to the potential problems in relation to medicines administration in children as the researcher (DD) would have experienced multiple episodes during their practice where parents that were not able to administer medication to their children, as well as some personal challenges that the researcher (DD) may have encountered themselves during administering medication to their own children.

4.6 Conclusion

This research found that medication administration issues and challenges exist among parents and young people at home. Parents and young people have issues related to dosage formulation that poses sets of challenges among parents when administering the medication to their children. To overcome these issues, parents will come up with persuading techniques to administer the medication; however, this leads sometimes to inaccurate dose administration.

The provision of medication administration instructions is another challenging matter for parents. Unclear, insufficient and / or inconsistent information provided puts parents under pressure, and on some occasions has led to parents using unreliable resources on the internet for more administration information. Furthermore, parents discussed their experience and preference in regards to medication instructions. The majority of the participants expressed that they will rely on the doctor or labels for medication administration instructions.

Finally, parents provided some recommendations regarding safer medication administration at home based on their own experience. Parents feel that they might be more confident having a healthcare professional showing them how to prepare their child's dose as part of their counselling. During which, information on how to hold their child (baby/infant) when administering the medication should be provided, as well as, tips on taste-masking when unpleasant medication is prescribed.

Although medication administration has long been acknowledged as an issue, however, many unanswered questions remain. This brings into sharp focus the largely unexplored area of the medication administration issues among children aged between 0 to 18 years old in the UK. This study was qualitative, where parents and young children were involved in providing insight into their daily challenges with medication administration at home. One of the strengths of this study was that it was conducted in children's specialist hospitals in three cities in England, hence improving the generalisability of the findings. Nevertheless, the study highlights the need for larger scale research involving parents and young children, as well as stakeholders such as pharmaceutical companies, healthcare providers and prescribers, to further capture not only the extent and the prevalence of these issues but also the consequences of their occurrence on the child's health.

Chapter 5 - Realising the issue of medicine administration to the young (REMEDY): Phase Two Findings

5.1 Introduction

In an outpatient setting, medication administration errors among children frequently occur, with evidence indicating that 50% to 70% of parents make liquid dosing errors (Simon and Weinkle, 1997;LI et al., 2000;McMahon et al., 1997). In the United States (US), it is estimated that up to 70% of caregivers administer over the counter liquid medication inaccurately; however, this information has not been researched in the UK (Frush et al., 2006;LI et al., 2000;Gribetz and Cronley, 1987;Simon and Weinkle, 1997). In a cross-sectional observational study that enrolled 200 patients aged 10 years and younger, 51% of the patients received an inaccurate dose of liquid medication from their parents (LI et al., 2000). Mismeasuring the dose could lead to a suboptimal therapeutic outcome, where not only is not enough dose given, it could be that too much is given, or the dose could be varied that the patient is never stabilised. In March 2007, the National Patient Safety Agency (NPSA) released a report regarding medical devices and, the methods used to measure and administer oral liquid medicines. It looked into how it can improve patient safety (NPSA, 2007). The document states that, from September 2007, all patients or carers who need to administer liquid medication should be supplied with oral/enteral syringes to improve patient safety. Although, in practice, most liquid medications are currently provided to paediatric patients with a suitable measurement tool, dosing errors still occur. This leads us as a research team to further look into the issue of dosing errors from a parental perspective and further ascertain the possible risk factors that influence dose accuracy among parents.

Evidence has found that there may be an association between parental ability to measure the dose accurately and health literacy levels, as well as the measurement tool used (Yin et al., 2007;Williams et al., 2019;Samuels-Kalow et al., 2013). Health literacy, which is defined as “The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions” is one factor that could be linked to medication administration errors (Manganello, 2008). Prior studies have associated limited health literacy with dosing errors (Yin et al., 2014b). In England, almost 61% of the working-age population found it difficult to understand health and well-being information reported by Public Health England in 2015 (Public Health

England, 2015). In order for parents to accurately prepare and administer liquid medication to their children, they must first understand the written medication instructions found on the medication`s label and apply these instructions using a dosing measurement tool. For this to happen, certain literacy skills are needed: prose literacy, document literacy and quantitative literacy (Yin et al., 2011). Among these skills, quantitative literacy skills are the most important for measuring out liquid medications for children. Often, it is required to split the dose to accommodate the required prescription dose (Yin et al., 2011).

One randomised controlled study looked at dosing tool size and its contribution to dosing error (Yin et al., 2017). They found that fewest dosing errors were seen when the measuring tool size was closely matched to the dose`s-volume; and the research team suggested that this could be a promising strategy to reduce dosing errors among paediatrics. In another study, even though oral syringes are considered the gold standard when dose accuracy is desired, 16.7% of the study participants used a non-standardised measurement tool (Yin et al., 2014b).

To the best of our knowledge, no previous studies have been conducted in England to assess dosing abilities of parents and young people in measuring out liquid medications. Therefore, this second phase was designed to assess the dose accuracy of the England`s parents and young people and whether there is an association with health literacy, and measurement tool type and size, as well as liquid type. In addition, it was designed to determine the risk factors that may affect the dosing ability of parents and young people, and give a better understating of the nature of these dosing problems and challenges occurring at home outside a clinical setting.

5.2 Methods

This was an observational (non-interventional) phase, where parents and informal caregivers of children aged between 0 and 18 years old were observed and assessed for dose accuracy using commonly available standardised measuring tools. Participants were asked to prepare a set of different volumes from two placebo liquids: a syrup, bottle A, which is cherry syrup, obtained from Optima (Swansea, United Kingdom; and a solution, bottle B which is normal saline (0.9% w/v NaCl) obtained from B. Braun (Melsungen, Germany). A £10 Love-to-Shop voucher was given to participants to thank them for their participation. The study was approved by the West Midlands - Black Country Research Ethics Committee in June 2019. The study participants were enrolled between August 2019 and January 2020.

An allocated key person in one of the NHS sites was assigned to work with the principal investigator (DD) to identify participant and seek an initial approval to take part in the study. The principal investigator consecutively assessed the participants' eligibly, and informed written consent was obtained prior to commencing with the study activity ***(See appendix O and P for consent forms)***. Participants from the university were sent an invitation email through the official staff and student e-mail system, and interested participants contacted the research team (CH, DD) via email ***(See appendix L for the invitation letter used for both phases)***. A study participant information sheet (PIS) was sent to the potential participants and, upon assessing their eligibility, written informed consents were obtained ***(See appendix Q to U for study participant information sheets).***

5.2.1 Participants (eligibility criteria) and setting

Parents or informal caregivers who have a child aged 0 to 18 years old and young children aged 16 to 18 years old who speak English and are responsible for administering the medication to their children or taking their own medication by themselves were eligible for the study. Participants were parents or informal caregivers or young people who attended one of the four NHS children's specialist hospitals: children's hospital' in Liverpool (North West England- Site A); the children's hospital' in Birmingham (West Midlands-Site B); and two children's hospitals in London (South East-Site C and Central London-Site D); as well as to staff and students of an educational institution

in the (West Midlands - Site E). Depending on the study site capacity, the observational session was done in either a private consultation room or at the bed side. Prior to each session and to ensure that all the sessions were conducted similarly, the PI followed a guide (section 5.2.3. explains the steps that were done prior each session) to set up the session.

5.2.2 Dosing accuracy (what happened in each observational session- step by step)

Parents' dosing errors were obtained by direct observation while weighing out the requested doses. Before each of the conducted observational sessions, the PI (DD) prepared two sets; A and B. Set A included Cherry syrup, whilst set B included normal saline. For both sets, the following measurement tools were also provided: a) two 1 ml syringes (standard and ENFit™ type); b) two 2.5 ml syringes (standard and ENFit™ type); c) two 5 ml syringes (standard and ENFit™ type); d) two 10 ml syringes (standard and ENFit™ type) e) one 10 ml measurement cup; and f) one standardised 5 ml measurement spoon (see Table 5.1). Each participant was provided with new sealed syringes to withdraw the required dose and, upon completion of the session, the syringes were discarded.

Each participant was presented with an observational guide (written instructions) to help the recruited participants remember the measurement doses to be withdrawn from each liquid. Each recruited participant, upon consenting, was provided with a brief on what they will be doing and the PI explained what the participant was required to do using the guide to ensure similar information was provided to all participants in this study (See appendix V and W for observational instruction guide that was provided to the participants). Using the written instructions, participants were asked to prepare the following volumes: 0.55 ml, 0.75 ml, 1.6 ml, 4.5 ml, 5.8 ml, 7.5 ml and 10 ml from the two liquid bottles (A and B).

After the instruction was provided, the participant measured the required doses from each liquid, one dose at a time, during which the PI took some observational notes from the session. Once the participant had measured a certain dose (e.g. 0.55 ml), the participant handed the measurement tool containing the measured dose to the PI. The combined weight of the

measurement tool and the measured dose was recorded using a calibrated digital scale sensitive to 2 decimal places (i.e. ± 0.05 g), with the measured dose then calculated by subtracting the pre-determined weight of the empty measuring tool. The same balance (Sartorius, Quintex laboratory balance, from Sartorius AG, (Goettingen, Germany)) was used across all the observational sessions. The PI also recorded the type and size of measurement tool chosen. Each participant in this phase withdrew each of the listed dose volumes once.

Table 5. 1: Measurement tools presented to the participants during the session

Tool size and (type)	**Picture**
1ml (Standard, Medicina Brand, oral syringe)	
1ml (Medicina ENFit ™ Type)	
2.5ml (Standard, Medicina Brand, oral syringe)	
2.5ml (Medicina ENFit™ Type)	
5ml(Standard, Medicina Brand, oral syringe)	
5ml (Medicina ENFit™ Type)	
10ml (Standard, Medicina Brand, Oral syringe)	
10ml (Medicina ENFit™ Type)	

Dosing Cup (30 ml)	
5ml Measurement Spoon	

5.2.3 Dose measuring references

After determining the participant's measured dose, the magnitude of any dosing error was calculated using the density of the liquids investigated. The theoretical density of normal saline was used as a reference point, which is 1.00482 g/ml (Chemistry, 2017). For the cherry syrup liquid, the density (1.507 g/ml ± 0.058 g/ml) was calculated by taking an average weight (n = 5) of 1 ml of cherry syrup, measured using a calibrated pipette (Gilson, (WI, USA)) and weighed using a digital analytical balance (Sartorius, Cubis II laboratory balance, from Sartorius AG, (Goettingen, Germany)) sensitive to 3 decimal places (i.e. ± 0.005 g) ml. Then the correct weight for each volume dose was calculated using these density values as a reference point (Table 5.2). In calculating the volume of each sample, the below equation was employed:

$$Dose\ volume\ (ml) = \frac{Sample\ weight}{Density\ (reference\ point)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots Eq(1)$$

For example, a participant sample for 0.55 ml syrup weighed 0.51 g. The volume of this sample was calculated using equation 1 as follows:

$$Volume = {}^{0.51}/_{1.507} = 0.338\ ml$$

Participants' doses were considered accurate if the weight of the dose was within 20% of the recommended dose; whilst greater than a 20% deviation from the intended dose was deemed to be inaccurate. This is a theoretically acceptable threshold used previously by other studies of medication

dose accuracy (Yin et al., 2010;Yin et al., 2017) . This 20% threshold was set arbitrarily in an artificial environment and does not take into account that in actual clinical practice there would be drugs that require accurate dosing, e.g., with a narrow therapeutic range. Once accuracy or inaccuracy levels were calculated, the frequency of accurate and inaccurate doses was calculated and compared as a function of different tested variables.

Table 5. 2: The reference weight in grams per dose volume for both cherry syrup and normal saline.

Dose Volume	Liquid	Reference Weight(g)
0.55 ml	Cherry Syrup® (Bottle A)	0.83
	Normal Saline® (Bottle B)	0.68
0.75 ml	Cherry Syrup® (Bottle A)	1.13
	Normal Saline® (Bottle B)	0.92
1.6 ml	Cherry Syrup® (Bottle A)	2.41
	Normal Saline® (Bottle B)	1.97
4.5 ml	Cherry Syrup® (Bottle A)	6.78
	Normal Saline® (Bottle B)	5.53
5.8 ml	Cherry Syrup® (Bottle A)	8.74
	Normal Saline® (Bottle B)	7.13
7.5 ml	Cherry Syrup® (Bottle A)	11.31
	Normal Saline® (Bottle B)	9.22
10.5 ml	Cherry Syrup® (Bottle A)	15.83
	Normal Saline® (Bottle B)	12.91

5.2.4 Assessment of participants' health literacy

The participants' health literacy level was assessed in person before starting the observational session using the Newest Vital Sign (NVS) Test ***(See appendix N for the NVS tool used to access participants' health literacy levels)***. This test has been modified and standardised to the UK population. A score of 0 or 1 reflected a high likelihood of limited literacy levels; 2 or 3, possible limited literacy levels; and 4 to 6, adequate literacy levels. The age of the parents or informal caregivers, or young patient was collected. For analysis purposes, based on (DK) advice, to withdraw association conclusions between dose accuracy and health literacy levels as well as due to the lower number of participants in the high likelihood of limited health literacy category, the categories of health literacy were split into an adequate group and a non-adequate group. If the participants scored limited health literacy or high likelihood of limited literacy levels on the NVS-UK tool, they were considered as in the inadequate group.

5.2.5 Variables

The variables for this phase were as follows:

a- The tested liquids: two liquids were used in this observational study to mimic the commercially available liquids for children; a syrup (bottle A, cherry syrup) and a solution (bottle B, 0.9% normal saline).

b- The tested dose volumes : the following seven dose volumes were tested by each participant per liquid type (0.55, 0.75, 1.6, 4.5, 5.8, 7.5, and 10.5 ml).

c- The types and sizes of the tested measurement tools (see table 5.1): medicina oral syringe, and medicina ENFit™ type syringes (capacity: 1 ml, 2.5 ml, 5 ml, and 10 ml) were available in front of the participants to choose from, along with a measurement spoon (5 ml) and measurement cup (30 ml). The participant was able to choose any type of measurement tool to withdraw the required dose.

d- Adaptors: a universal adaptor for the liquid bottles was provided to each participant.

e- Health Literacy: the health literacy of each participant was tested using the validated Newest Vital Sign heath literacy tool.

5.2.6 Statistical analysis

The Shapiro-Wilk test was used to assess for normality of the data using IBM SPSS Statistics 26. The results of this test showed that the data collected for this phase was not normally distributed. Hence, to test for correlation between dose accuracy and the other variables (such as health literacy, dose volume, measurement tool type, and measurement tool volume and liquid type) the Pearson Chi-Square test was selected to provide a complete description of the association.

For all the analysis, Pearson Chi-Square Asymptotic Significance (2-sided) < 0.05 was considered statistically significant.

5.3 Results

Forty-six participants from five sites across the United Kingdom were recruited, and only 40 were included in the final analysis of this phase. The other four participants were not included in the final analysis due to missing information on the collection sheet.

Almost all approached participants agreed to take part in this study except for five participants who refused to take part primarily due to other commitments such as returning to work or they were unfamiliar with the liquid syringe measurement tools. Two participants withdrew from the study upon measuring the first couple of doses; see ***Figure 5.1*** for the recruitment process. These two participants felt overwhelmed with measuring liquid medications and decided to withdraw from the study; one was a young adult aged between 16 to 18 years old; and one was an adult aged above 50 years of age.

The majority of the informal caregivers were aged between 36 and 45 years old, with the youngest participant aged 18 years old and the eldest 53 years old. Almost half of the participants (47%) scored an adequate health literacy level, followed by a reasonable proportion (44.9%) with limited literacy and a minority (8.1%) of the participants scored a high likelihood of limited literacy on the NVS-UK literacy test. For data analysis and reporting purposes, health literacy levels were divided into two categories: adequate health literacy levels, which included all participants who scored adequate health literacy levels on the NVS-UK tool; and inadequate levels, which included participants who scored either limited health literacy levels or a high likelihood of limited literacy levels. Descriptive data of the forty-four participants' characteristics are shown in ***Table 5.3***.

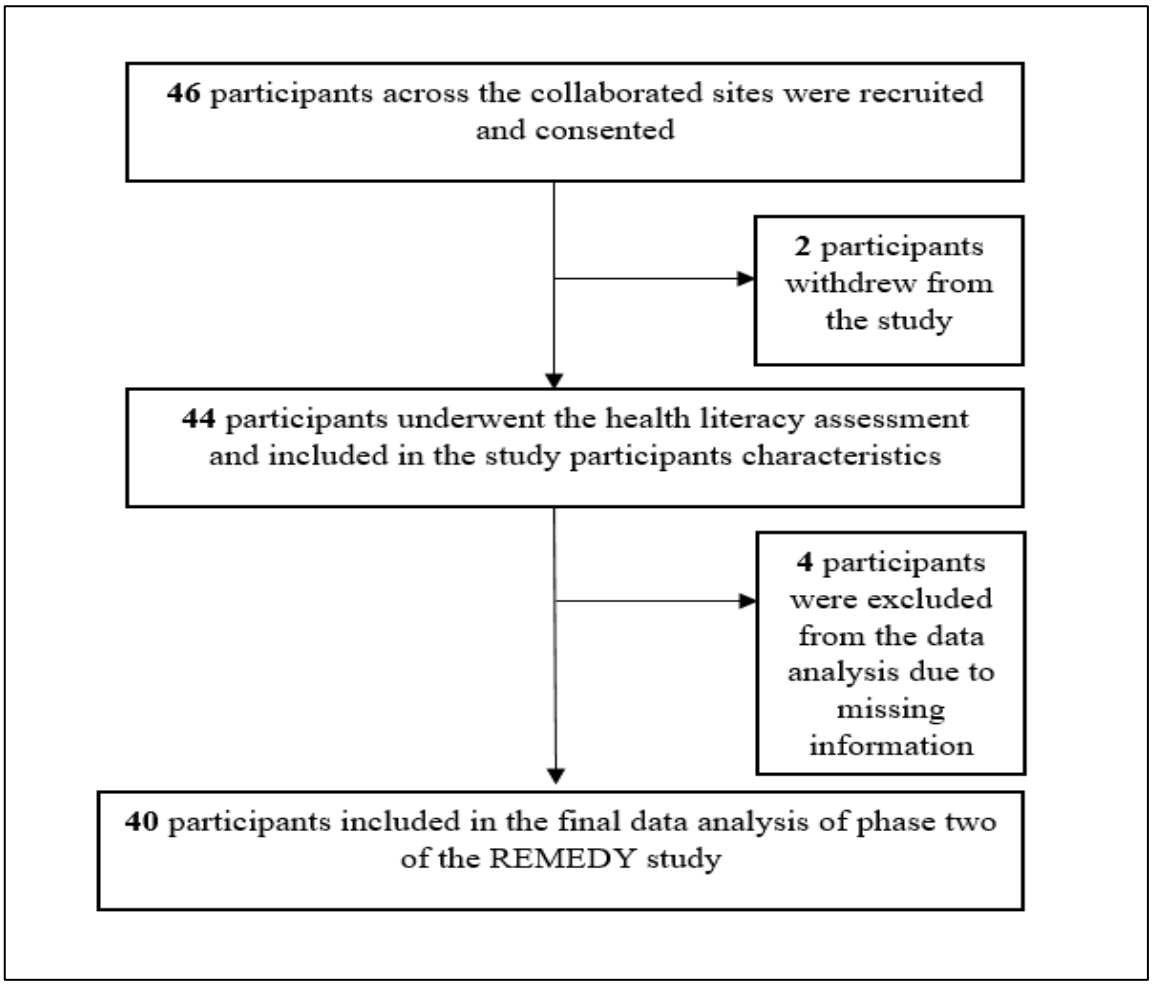

Figure 5. 1: Flow chart outlining the recruitment process of phase two REMEDY study

Table 5. 3: Participants Characteristics of all consenting particpants including the participants that were not included in the final analysis due to missing data

Participants Characteristics	**Total% (n =)**
Age (in years)	
16-18	2.3% (n = 1)
19-35	36.4% (n = 16)
36-45	54.5% (n = 24)
46 and above	6.8% (n = 3)
Setting (City, region)	
Site A- Children`s Hospital (Liverpool, North West)	27.3% (n = 12)
Site B- Children`s Hospital (Birmingham, West Midlands)	27.3% (n = 12)
Site C- Children's Hospital (London, South East)	11.4% (n = 5)
Site D- Children's Hospital (London, South East)	25% (n = 11)
Site E-Educational Institution (Birmingham, West Midlands)	9.1% (n = 4)
Literacy Level *	
Adequate health literacy	41% (n = 18)
Possibility of limited literacy	50% (n = 22)
High likelihood (50% or more) of limited literacy	9% (n = 4)

Note:* For analysis purposes health literacy was divided into adequate health literacy levels and inadequate health literacy levels; the inadequate health literacy levels included both possibility of limited literacy and high likelihood (50% or more) of limited literacy.

5.3.1 Dose accuracy for both syrup and solution liquids

Each participant in this phase withdrew the listed dose volumes once, so each dose volume per liquid type has 40 repeats. When the participants were asked to withdraw the pre-set dose volumes from the syrup (bottle A; cherry syrup), only n = 5/40 (12.5%) measured out an accurate dose of the 0.55 ml dose volume, with an average deviation from the dose of 64.29%. While just n = 3/40 (7.5%) measured out the 0.75 ml syrup dose volume accurately, with an average deviation from the dose of 58.32%. The majority of the participants (n = 30/40 (75%)) measured out the 1.6 ml syrup dose accurately, with an average deviation from the dose of 18.99%; and n = 27/40 (67.5%) measured out the 4.5 ml syrup dose accurately, with an average deviation from the dose of 18.85%. For the 5.8 ml syrup dose volume, n = 24/40 (60%) accurately measured the dose and 20.25% was the average deviation from it. While for the 7.5 ml syrup dose volume, n = 26/40 (65%) measured the dose required accurately, with an average deviation of 18.72%. For the 10 ml syrup dose volume, the majority of the participants n = 30/40 (75%) measured the dose correctly, with an average deviation of 15.23% ***(See Table 5.4).***

When the participants were asked to measure the proposed dose-volumes of the saline solution liquid (bottle B; normal saline), n = 28/40 (70%) of the participants accurately measured the 0.55 ml dose volume, with an average deviation from the dose of 74.95%. While the majority n = 32/40 (80%) measured out the 0.75 ml dose accurately, with an average deviation from the dose of 860.63%. When the participants were asked to measure the 1.6 ml dose volume, n = 27/40 (67.5%) measured the dose correctly, with average deviation from the dose of 16.41%; while for the 4.5 ml, n = 34/40 (85%) measured the dose accurately, with an average deviation of 8.56%. For the 5.8 ml dose, n = 32/40 (80%) of the participants measured it within the 20% cut-off point, with average deviation of 11.08%. And for both the 7.5 ml and the 10.5 ml dose volumes, n = 31/40 (77.5%) and 35/40 (87.5%), respectively, of the participants measured the dose volume accurately within the 20% cut-off point, and with average deviation of 10.16% and 9.55% respectively ***(See Table 5.4)***.

Overall, for the cherry liquid syrup (bottle A), the smaller dose volumes (0.55 ml and 0.75 ml) were not measured out accurately when compared to the larger dose volumes (1.6 ml, 4.5 ml, 5.8 ml, 7.5

ml and 10.5 ml) from the same liquid type. For the smaller doses (0.55 ml and 0.75 ml), the dose accuracy (number of participants) was higher for the solution liquid over the syrup type. That means the percentage of the participants who measured those smaller dose volumes accurately were more predominant with the solution type liquid. There is a significant association between dose accuracy and dose volume ($p<0.001$, Pearson Chi-Square Asymptotic Significance (2-sided)).

Figure 5.2 illustrates the overall number of the participants for both liquid types who measured each dose volume accurately within the 20% cut-off point, and the number of the participants per dose volume who did not measure the dose accurately (more than 20% off the cut-off point).

Table 5. 4: Dose accuracy per dose volumes and per liquid type

Dose Volume	Dose accuracy for Syrup (Bottle A)	Dose accuracy for Solution (Bottle B)
	n (%) of the participants who measured an accurate dose (<20%)	n (%) of the participants who measured an accurate dose (<20%)
0.55 ml	5 (12.5%)	28 (70%)
0.75 ml	3 (7.5%)	32(80%)
1.6 ml	30 (75%)	27 (67.5%)
4.5 ml	27 (67.5%)	34 (85%)
5.8 ml	24 (60%)	32 (80%)
7.5 ml	26 (65%)	31(77.5%)
10.5 ml	30 (75%)	35 (87.5%)

Note: Total number of participants recruited and included in the final analysis of this phase were (n = 40); so number of repeats per dose volume per liquid type was 40; total number of experiment dose was 560; Pearson Chi-Square Asymptotic Significance (2-sided) is .000.

Furthermore, the percentage deviation from the dose for each dose volume measured was calculated for the suspension liquid and the solution liquid. For both liquids, the average deviation for each dose are presented in ***Table 5.5***.mlmlmlmlmlmlmlmlmlmlml

Table 5. 5: Average deviation from the dose at each dose volume for each liquid type along with the largest overdose and largest underdose done by the participants

Dose Volume	Average deviation from the dose	
	Suspension (Bottle A)	**Solution (Bottle B)**
0.55 ml	64.29%	74.95%
0.75 ml	58.32%	60.63%

1.6 ml	18.99%	16.41%
4.5 ml	18.85%	8.56%
5.8 ml	20.25%	11.08%
7.5 ml	18.72%	10.16%
10.5 ml	15.23%	9.55%

***Note:** None of the participants made an overdose error, all of the participants who made an error did an underdosing error.

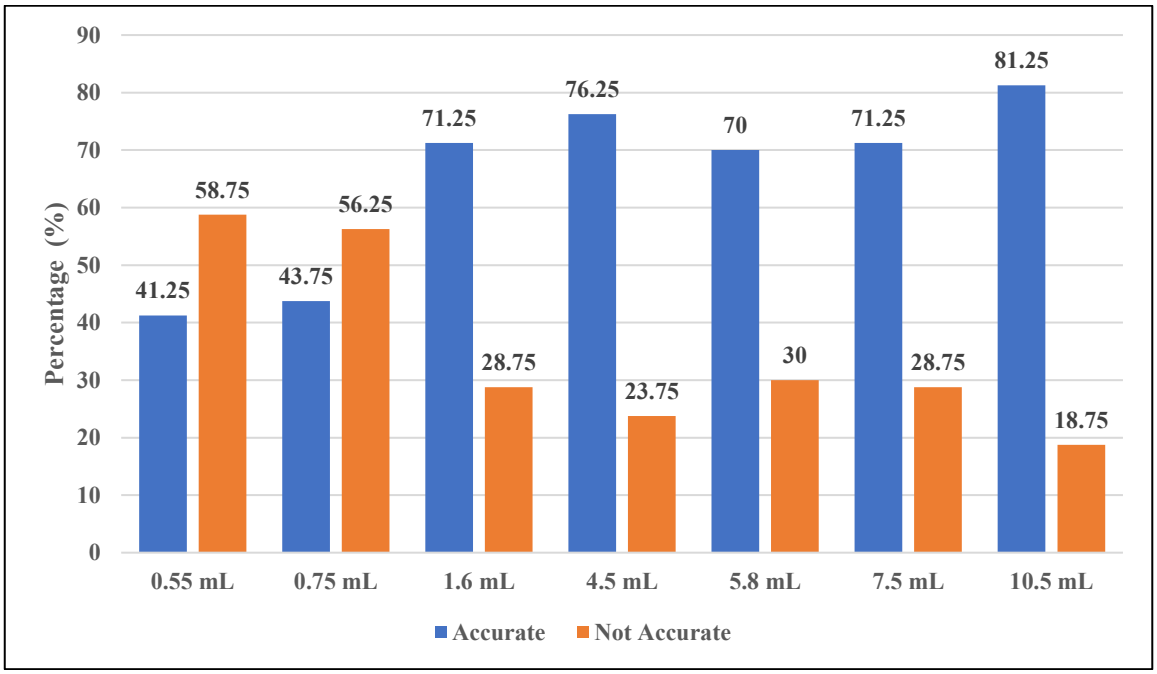

Figure 5. 2: Percentage of dose accuracy per dose volume for both liquids tested.

In order to further analyse the data and establish an association between causality factors that could contribute to dose accuracy, the Pearson Chi-Square test was used to find a correlation between dose accuracy and the following identifiable causality variables: 1- Liquid type, 2- Health literacy levels, 3- Tool volume and 4- Tool type.

5.3.2 Liquid type and dose accuracy

In this phase, two liquid types were tested: cherry syrup (bottle A) and normal saline solution (bottle B). For both liquids, the majority of the participants (n = 364/560, 65%) measured the requested dose

volume within the 20% cut-off point. However, the dose accuracy numbers were greater for the solution liquid (bottle B) type (n= 219/280, 78.2 %) compared to the syrup liquid (Bottle A) (n = 145/280, 51.8%). Furthermore, there was a significant association $P = .000$ between dose accuracy and the liquid type tested ($p<0.001$, Pearson Chi-Square Asymptotic Significance (2-sided)). ***Table 5.6 and Figure 5.5*** show the overall number of participants who accurately and inaccurately measured the requested dose per liquid type.

Table 5. 6: Dose accuracy per liquid type

Dose accuracy	Liquid Type			Pearson Chi-Square Asymptotic Significance (2-sided)
	Syrup (Bottle A)	Solution (Bottle B)	Total	
Not accurate >20%	135	61	196	.000
Accurate <20%	145	219	364	
Total	280	280	560	

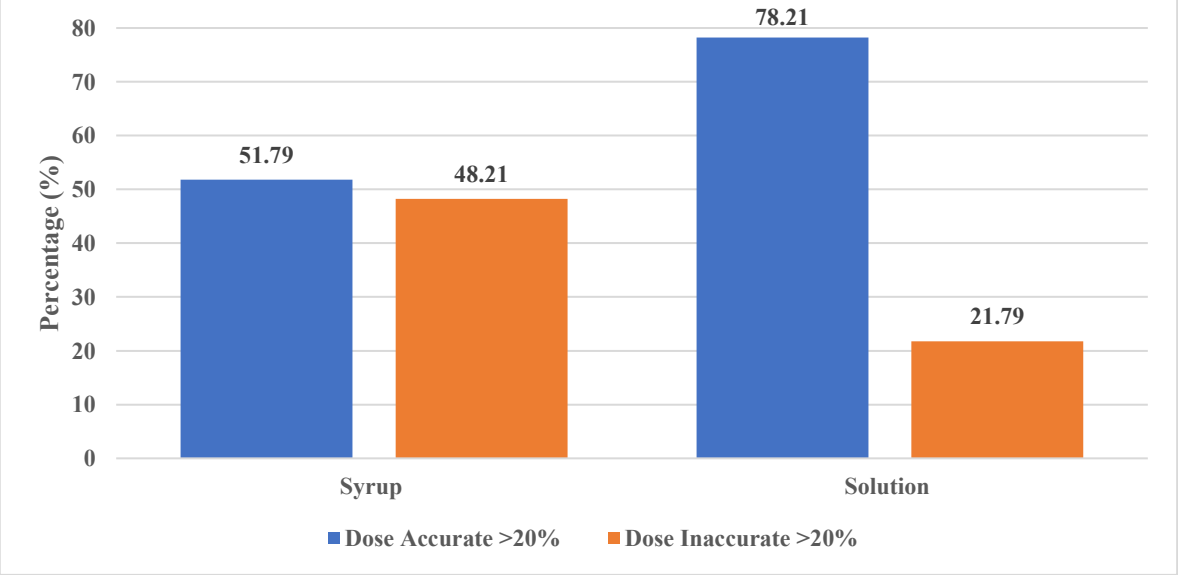

Figure 5. 3: Percentage of participants who accurately and non-accurately measured a dose per liquid type

5.3.3 Health literacy levels and dose accuracy

Overall, the health literacy of 40 participants was measured and included in the analysis. Each participant measured 7 doses from each liquid; therefore, each participant measured 14 doses, so that's 560 data points in total. For the participants who demonstrated adequate health literacy (n = 210), of the various dose volumes measured,31.90% were performed accurately (<20% of the dose-volume). For the participants who demonstrated inadequate health literacy (n = 350), of the various dose volumes measured, 38.86% were performed accurately (<20% of the dose volume) ***(See Table 5.6)***. The majority of the participants, n= 221(39.46%), who measured the dose inaccurately scored an inadequate health literacy levels. Overall, the Pearson Chi-Square test revealed a non-significant correlation *P* = 234 between health literacy levels and dose accuracy ***(See Table 5.7). (Figure 5.6***) displays the number and percentage of participants per health literacy levels and dose accuracy.

Table 5. 7: Dose accuracy and health literacy levels correlation

Dose accuracy	Health literacy levels (n)			Pearson Chi-Square Asymptotic Significance (2-sided)
	Adequate	Inadequate	Total	
Not accurate >20%	67	129	196	0.234
Accurate <20%	143	221	364	
Total	210	350	560	

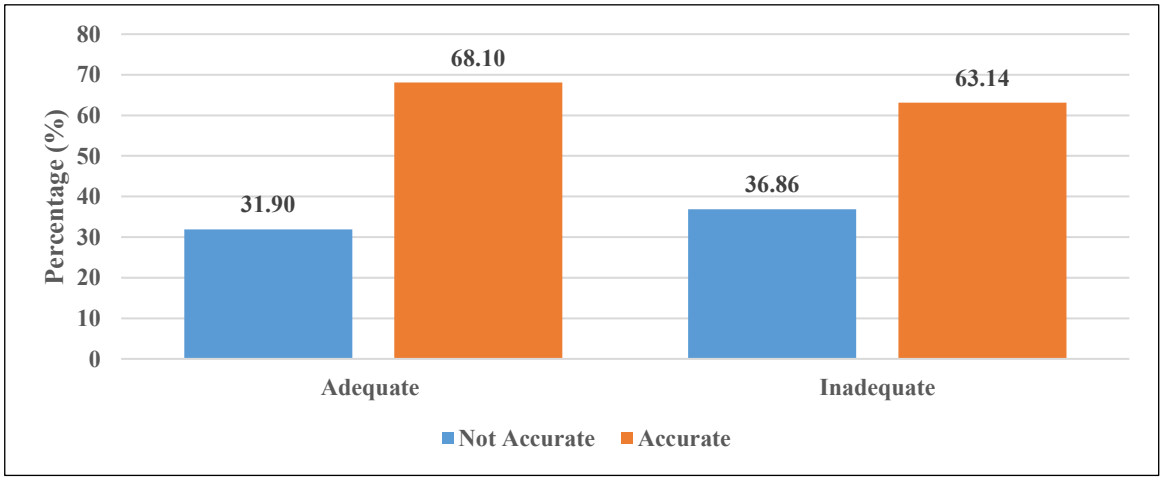

Figure 5. 4*: Percentage of accurate and inaccurate doses as a function of health literacy levels for both liquids*

5.3.4 Dose accuracy and measurement tool volume

Another variable with a significant association with dose accuracy, shown by the Pearson Chi-Square test $P = .000$, is the measurement tool's volume or size, selected by the participants to measure the dose volume requested. Overall, the syringe volume of 10 ml was the most preferred (chosen) by participants for measuring doses, representing 34.1%, whereas the combination of measuring tools (cup and a spoon; the spoon and the 1 ml syringe), were the least preferred (0.18% per each combination). When the 1 ml measurement tool size was used, the dose volume was accurately measured in 47% of the cases (n = 65 /139), and incorrectly measured in 53% (n = 74/139). When the 2.5 ml syringe size was used, the dose volume was correctly measured in 66% of the cases (n = 47/71), and inaccurately measured in 34% (n = 24/71). Furthermore, when the 5 ml tool size was selected by the participants, the majority (77% (n = 5470)) did measure the dose accurately within the 20% cut-off point, while 23% did not measure the dose correctly with this syringe size. When the 10 ml syringe size tool was used , the majority of the participants, accurately measured the dose volume (69% of cases (n = 132/191)), with inaccurate measurements in 31% (n=59/191) of the cases. Only n = 9 participants used the cup, which came in a 30 ml volume size to measure the dose volume. The cup was associated with accuracy, as n = 6 out of 9 of the participants who selected this tool size did measure the dose correctly.

A few of the participants (n = 80 doses measured) chose to use a combination of two measurement tools to withdraw the requested dose, among which 25% (n = 20/80) of these participants did not measure the dose correctly. In the majority of cases (n = 43/80) where a combination of measurement tools was chosen, a combination of 10 ml and 1 ml syringe sizes was used, followed by n= 13/80 who used both 5 ml and 1 ml syringe sizes. Furthermore, n= 6/80 used both 10 ml and 5 ml syringe sizes to measure the dose; while n = 6/80 selected 5 ml and 2.5 ml, and n= 4/80 selected 10 ml and 2.5 ml. Only n = 4/80 used the 30 ml (cup) and 1 ml syringe size and n= 1/80 used both a spoon and a measurement cup to measure a dose volume. ***(Table 5.8 and Figure 5.7)*** show the number of participants per measurement tool size selected and dose accuracy.

Table 5. 8: Measurement tool volume selected by the participants and its association with dose accuracy

Measurement Tool Volume	Dose accuracy		Total	Pearson Chi-Square Asymptotic Significance (2-sided)
	Accurate (n)	Not Accurate (n)		
1 ml	65	74	139	.000
2.5 ml	47	24	71	
5 ml	54	16	70	
10 ml	132	59	191	
30 ml	6	3		
5 ml and 2.5 ml	3	3	6	
5 ml and 1 ml	12	1	13	
10 ml and 5 ml	3	3	6	
10 ml and 1 ml	35	8	43	
10 ml and 2.5 ml	4	0		
30 ml and 1 ml	1	2	3	
Cup and Spoon	1	0	1	

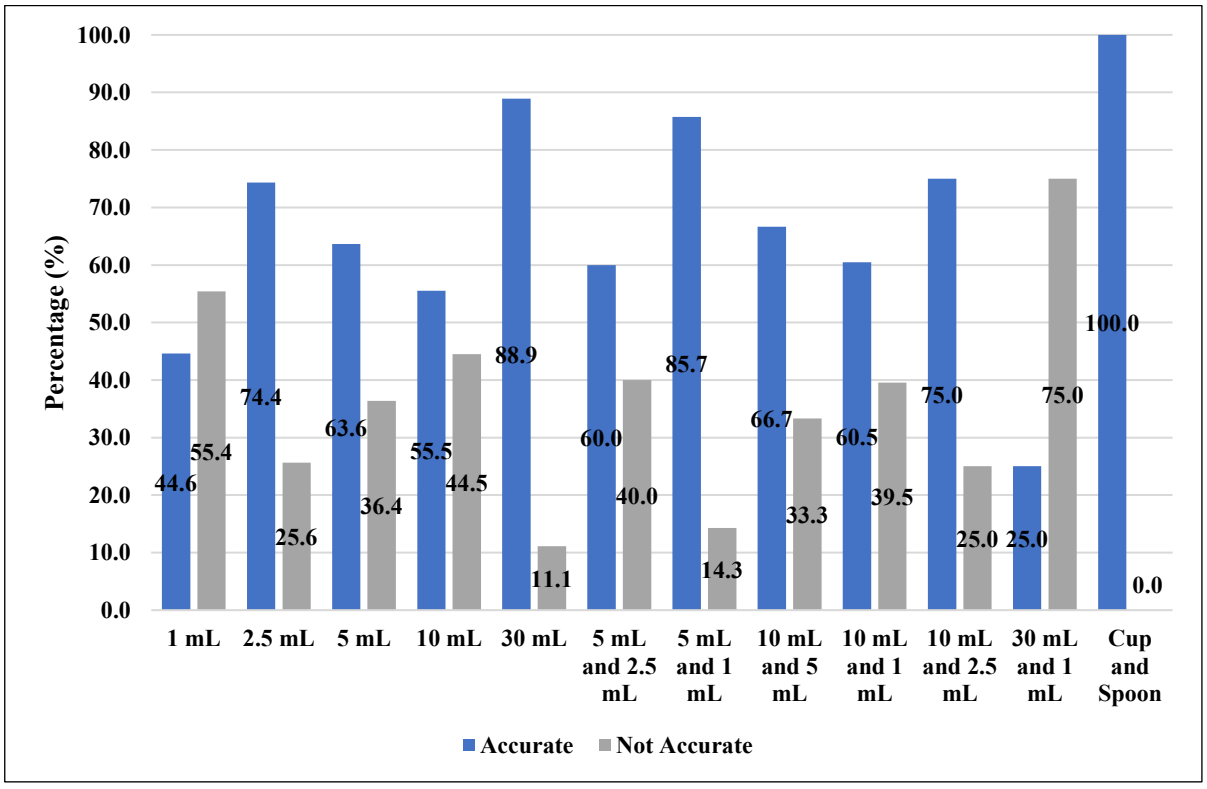

Figure 5. 5: Percentage of measurement tool volume selected by the participants and its association with dose accuracy

5.3.5 Measurement tool type and dose accuracy

This study examined two types of syringes to test for dose accuracy, the normal oral tip syringe type (standard medicina oral syringe), referred to as "normal" syringe for the rest of this chapter, and the ENFit™ enteral syringe type. In total there are 560 data points, as each one of the 40 participants measured in total 14 dose volumes. Among these data points, 295/560 representing 52.7% of the participants used a normal oral tip syringe type. Within this group, 72% of the participants, (211/295) did measure the dose correctly within the 20% cut-off point. The ENFit™ syringe-type was chosen by 38.03% of the total data points (n = 213/560); among these where this type of syringe was selected, 54% (n = 114/213) did measure the dose correctly, while 46% of the cases (n = 99/213) did not correctly measure the dose volume. A number of the cases n = 40 used two measurement tools from different types of syringes (mixed two types: normal and ENFit) to measure out a requested dose, and n = 8/40 did not measure out the dose accurately. Also, a few of the cases n = 7/12 who used a measurement tool spoon or cup or a combination of these both measurement tools did accurately measure the dose prepared. Finally, measurement tool type had a significant association with dose accuracy *P*=.000. **(*Table 5.9 and Figure 5.8)*** show the number of participants who used each measurement tool type and the dose accuracy per tool type. ***Table 5. 9: Measurement tool type and dose accuracy***

Dose accuracy	**Tool Type**					**Pearson Chi-Square Asymptotic Significance (2-sided)**
	Normal (n)	**ENFit (n)**	**Both Types*(n)**	**Others** (n)**	**Total (n)**	
Not accurate >20%	84	99	8	5	196	.000
Accurate <20%	211	114	32	7	364	
Total	295	213	40	12	560	

Note: * This includes participants who used two different types of syringes to measure out the requested dose volume

** This includes measurement spoon or cup or a combination of cup or spoon with other syringe types.

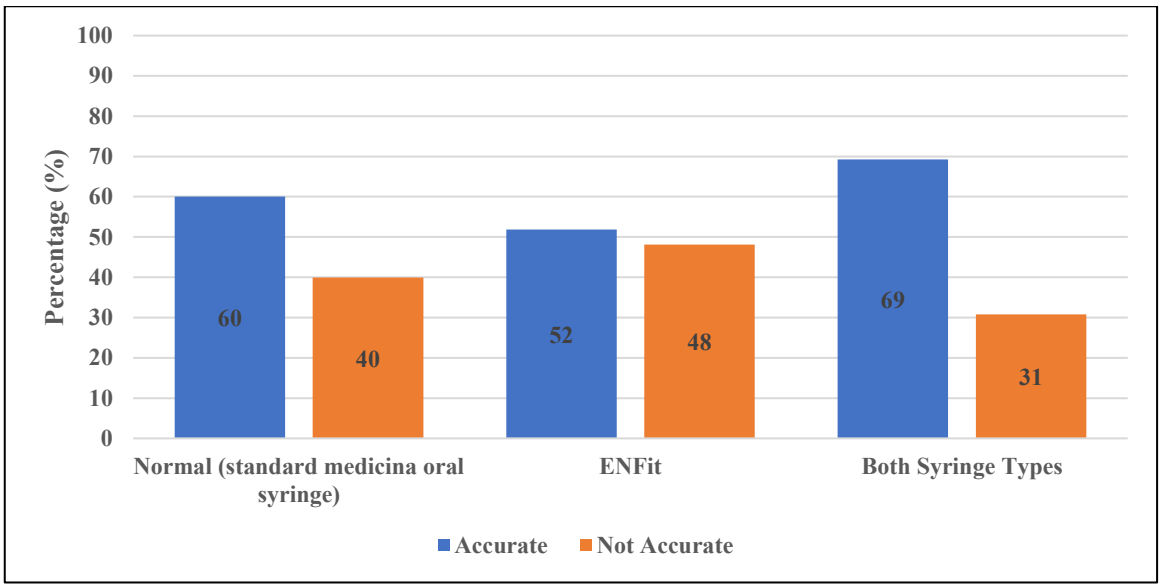

Figure 5. 6: Measurement tool type and dose accuracy

5.3.6 General observations of parents and young people preparing syrup (Bottle A):

Among the 44 participants included in the study, only one (2.27%) participant shook the cherry syrup bottle before measuring the doses. The majority of the participants did not remove extra air bubbles from the measurement syringe before handing it to be weighed. For the syrup, participants were more concerned to get the right dose and ignored the air bubbles. While preparing the doses, the participants made a lot of mess in the form of spillage on the work top as well as around the measurement tool, and this seemed to occur more with the ENFit™ syringe type. Few participants used the adaptor that fits the bottle; it was often stated that they prefer the already fitted adaptor to the bottle and not the one that they need to fit in, as this could lead to more mess and requires more cleaning afterwards. A small number of the participants were not sure for what the adaptor should be used. Due to the dark-coloured syrup, some parents struggled to read the numbers on the syringe and estimated the dose. Many parents requested some further explanation of which part of the syringe they need to follow for dose accuracy; for example, is it at the end of the black stopper or the tip of it. A few were not sure whether the tip of the syringe should be included in the dose, or if they have to leave it empty. For a 10.5 ml dose, many parents did not bother to measure the 0.5 ml and stated that they would do the same at home for their children. It was found that 11.4% (n = 5/44) of the parents said that they prefer the ENFit™ type syringe to the normal one. Some parents expressed their concern in regards to the bottles themselves, stating as they might find them difficult to open.

		
P7: The participant withdrew the following volumes to prepare the 10.5 ml dose using both 10 ml and 1 ml syringes. **(a lot of bubbles in the syringe)**	**P13:** The participant withdrew the following volumes to prepare the 10.5 ml dose using both 10 ml and 5 ml syringes. **(Overdosing error)**	**P15:** The participant used the cup to prepare the 10.5 ml dose. The participant guessed the dose. **(Inaccurate dose)**

Figure 5. 7: Sample pictures of the participants measurements for Cherry Syrup.

5.3.7 General observations of parents and young people preparing solutions (Bottle B):

During the preparation of the solution doses, an issue relating to the colour occurred. On multiple occasions, participants thought that they had withdrawn a certain dose amount; however, in fact, there was nothing in the syringe. While measuring the solution, participants concentrated more on removing air bubbles trapped in the syringes. Nevertheless, 33/40 of participants did not remove air bubbles, especially when preparing the bigger volumes (4.5 ml, 5.8ml, 7.5 ml and 10.5ml). It was clearly observed that many small air bubbles were found at the base of the normal syringe type. Participants were cleaner and less messy during the preparation of normal saline doses as opposed to the syrup.

		
P13: The participant was confused with the decimal and thought that 0.5 ml is 5 ml. **(overdosing error)**	**P15:** there was a lot of bubbles at the base of the syringe.	**P27:** the participant was withdrawing 4.5 ml using both syringes, but due to the clear colour, the participant did not notice that they have not withdrawn any liquid. **(Inaccurate dose)**

Figure 5. 8: Sample pictures of the participants measurement for normal saline

5.3.8 Suggestions made by the participants regarding improving dose accuracy or issues raised based on observation of participants drawing up the volume

Overall, during the observational sessions, many queries were raised by the participants that are worth highlighting, and there are some practices that need attention from healthcare professionals and policy and guidance makers. These potential points could further improve medication administration among children and young people at home and provide further guidance and confidence to parents while administering medication to their children at home. These are suggestions related to the type of counselling provided by a healthcare professional to patients or parents or carers with regards to: liquid medications, syringes and how to use them correctly; the liquid medication itself and the bottles that they are supplied in; and guidance leaflets for parents.

5.3.8.1 Counselling and guidance

Parents need more guidance and tips on removing air bubbles from a measurement syringe and a reminder by a healthcare professional about the importance of removing these bubbles. When an adaptor was supplied with the syringe that was not already integrated into the bottle, the participant often preferred not to use it and said they usually dip the syringe in the bottle leading to a lot of excess liquid around the syringe that is being administered to the child. Potential guidance to those parents is needed on how to prepare the dose without using an adaptor as well as reminding them to clean the outer part of the syringe before administering the dose.

5.3.8.2 Liquid medication and the supplied bottles

There were issues related to the colour of the liquid medication. When the cherry syrup was used, participants complained about its dark colour and how it was hard for them to read the syringe numbers. Most of them did not remove the air bubbles from the syringe, which could be a potential risk or making a dosing error. Moreover, when normal saline was used, the clear colour solution made parents believe that they had withdrawn the liquid from the bottle, but in fact, they had not.

Therefore, participants suggested a clear yet lightly tinted liquid medication, which would be ideal for them to be confident when preparing a liquid medication dose.

5.3.8.3 Syringes

It was noticed that throughout the observational sessions that parents and young children did not know how to use the syringes correctly; a lot of uncertainties and questions were raised by the measurement process. For example, should the tip of the plunger be at the dose number or the base of the plunger? Should the tip of the syringe be filled with the liquid or empty when measuring the dose?

For the normal 5 ml syringe type, parents found it difficult to estimate the dose when asked to draw up a fraction of a dose, as decimals were not marked between the numbers. For 5ml ENFit™, if the participant was not using an adaptor, it was difficult to see the tip of the plunger, especially with the darker colour liquid. For the 10 ml size syringe, parents preferred the marking on the ENFit™ type syringe compared to the normal type. However, in general, the normal type syringes were marked clearly.

5.4 Discussion

To our knowledge, this study is the first to assess parents and young people for dose accuracy when measuring two types of liquids using various dosing devices in England. Our findings are that dose accuracy is not associated with health literacy levels, and liquid type, as well as measurement tool type and size. Dosing errors are alarming in regards to toxicity and suboptimal treatment or treatment failure (Kaushal et al., 2007;Winnick et al., 2005). Children in particular impose various challenges when it comes to medication administration; and are more vulnerable to adverse effects due to their size, and the complexity of their dosage regimen (a calculation is needed based on their age, body weight, and surface area etc.), resulting in more than 70,000 emergency department visits annually (Aseeri, 2013;Committee on Drugs, 2015)

In this study, 35% of the participants made a dosing error that is beyond 20% of the recommended dose; this finding is consistent with a previous study, where 41% of the parents gave a lower dose of acetaminophen, while 12% delivered an overdose to their children (Goldman and Scolnik, 2004).

Overall, dose accuracy was prevalent with the solution liquid type (78.21%, n=219/280) over the syrup liquid (51.8%, n=145/280); however, the number of participants who accurately measured the dose at each dose volume varied between the two liquid types tested. For the syrup, the majority of the participants did not measure the lower dose volumes correctly (0.55 ml (12.5%) and 0.75 ml (7.5%)), when compared to the solution liquid type at the same dose volumes (0.55 ml (70%) and 0.75 ml (80%)). The findings reported by Peacock and colleagues (2010) revealed that dosing errors with suspensions are higher when compared to solution, even after patient education (Peacock et al., 2010). Also, dosing errors are correlated with the viscosity of the dosage form. However, this effect is more profound when small volumes are measured, as a slight change in the volume of the syrup resulted in higher deviation from the target when compared to the solution as the density of the syrup is higher. This was not noted at higher volumes. At higher volumes, there was no difference in accuracy. Accuracy was improved across the rest of the proposed sets of dose volumes (1.6 ml, 4.5 ml, 5.8 ml, 7.5 ml, and 10.5 ml). For the solution liquid, the highest number of accurate dose measurement per dose volume was with 10.5 ml (87%). While 75% and 67.5% (syrup vs. solution) of the participants measured the 1.6 ml dose correctly across the two types of the liquids. The data in this study showed a significant association between tool size and dose accuracy. 71 participants choose the 2.5 ml syringe to measure a certain dose volume, and 47 measured the dose correctly with this tool size. This tool size (2.5 ml) was used to measure the 1.6 ml dose volume by 57 participants across both liquid types, among which 43 participants measured the dose correctly. Hence, the percentage of dose accuracy at this dose volume (1.6 ml) is high across the two liquids. For the 5.8 ml dose volume, 56 participants used the 10 ml syringe size to measure the dose for both liquids;40 measured the dose correctly with this tool size, which could be the reason behind the inaccuracy. Matching the dosing tool to the prescribed dose volume is a promising strategy that could potentially help reduce paediatric-dosing errors by parents (Shonna Yin et al., 2016;Yin et al., 2011;Torres et al., 2018). While more participants measured an accurate dose with the solution liquid, especially at

the lower dose volumes, over the syrup liquid, this varied across the dose volumes. This could be due to the colour of the syrup liquid used in this study. The cherry syrup liquid was very dark in colour, which made it a bit difficult for the participants to see the numbers that are inked in black on the measurement tool used, and in some cases the participants estimated the dose volume. In addition to that, a further disadvantage that may be seen with suspension liquid types is sedimentation, which could lead to further dosing inaccuracy if it is not shaken before use. Measurement tool volume has been associated with dose accuracy (McMahon et al., 1997;Grießmann et al., 2007). Dose accuracy for the solution liquid type was more accurate at the lower dose volumes when compared to the higher dose volume.

The measurement tools' size in our study was associated with dose accuracy; however, matching the right dosing tool size with the prescribed dose volume is crucial for dose accuracy as described above by previous studies. This has been further investigated by Arenas-López and her colleagues (2017) in an *in vitro* study looking at potential recommendations to reduce administration errors in dose volumes less than 5 ml. The study recommended using syringe sizes that are similar to the dose volumes (Arenas-López et al., 2017). Some of the participants chose to use two measurement tools to measure out the required dose. In these cases, the majority of the participants measured accurate dose, as they choose a closely matched tool size to the dose volume. However, using a combination of tools can pose some potential problems, such as greater loss during transfer or quantity left in the measurement tool, hence, a potential build-up of error.

When cups were used to measure out a dose volume, the majority of the participants measured the dose accurately, although this is inconsistent and not expected to previous studies where errors by parents were documented with measurement cups (Harris et al., 2017;Shonna Yin et al., 2016). The studies related this error to some confusion about the teaspoon versus tablespoon instructions provided to their participants, and the assumption that the cup is the full dose, which is not the case in this study (Yin et al., 2010). Participants were provided with ml units for the dose volume and the measurement cup had ml measurement units, hence, there was no confusion, and this reduced errors. Furthermore, only 9 (1.6%) participants used the cup in this study as their measurement tool of choice, which is a low number to draw conclusions from, and was used to measure larger dose

volume. However, these findings are consistent with a previous study conducted in the USA (Williams et al., 2019).

This study highlighted that there is no association between dose accuracy and health literacy levels of the participants. However, previous studies that have been conducted in the USA identified that parents' health literacy levels are significantly associated with dose accuracy (Harris et al., 2017;Samuels-Kalow et al., 2013). Although our study did not show any association of health literacy and dose accuracy, future studies looking at this aspect at a larger scale and perhaps with the ability to investigate further characteristics of the participants (i.e. socio-demographic data and, more importantly, medical history (what condition is being treated, is it chronic or acute, extent and level of experience with measuring/administering medication)) is needed here in the UK

In this study, two types of measurement syringes were tested: the oral syringe and the ENFit™ oral syringe type. Dose accuracy was more significant with the normal oral syringe type in comparison to the ENFit™ syringe. This is a key finding in this study as the ENFit™ type syringe is the syringe of choice that is dispensed with a liquid medication in the UK. This finding is consistent with previous data, where higher rates of dose inaccuracy were seen with the ENFit™ low dose enteral syringes, especially for higher risk medication (O'Mara, 2020). Such inaccuracy is possibly due to the design of the ENFit™ device. A recent study in 2020 reported that, for effective use of ENFit™, an adaptor needs to be used to accurately measure and administer liquid oral medication using such syringes, which can be challenging and possibly lead to dosing errors (Walsh et al., 2020). This could explain the dosing errors encountered with the ENFit ™syringe, as none of the participants used the adaptors provided with the ENFit™ syringe type in this study.

From the perspective of the parents and young people involved in the study, the need for further personalised counselling was documented, particularly on how to accurately measure a liquid medication. In addition, tailored tips and recommendations are needed depending on the prescribed dose, tool and the parents' and young people`s needs. This might include provision of the dose by a health care professional, and then the parent or the patients prepare a dose in front of the health care professional with the advanced (detailed) counselling to ensure dose accuracy. This has been

previously associated with decreased errors (Yin et al., 2014a;McMahon et al., 1997) (Yin et al., 2010). In addition, providing a pictographic dosing diagram as part of the written instructions to parents could be helpful for parents to achieve dose accuracy (Yin et al., 2011).

The implication of the findings of this study have been initially shared among the NHS sites collaborators, to discuss potential practical recommendations to improve medication administration among children and young people. It was agreed that further, larger scale studies are needed, and in order to achieve that a NIHR patient benefit grant to be submitted. Furthermore, one study site has already implemented a station on a cardiovascular ward where parents could practice liquid withdrawal and ask for health care professional support and confirmation about the volume withdrawn. This to help parents feel confident while administering the medication at home and allow the parent to ask question based on their child case and seek for professional advice if need prior to discharge.

There are limitations to our results. The assessment of dosing was performed as part of a hypothetical scenario and may not reflect the ability of parents and young people to administer a liquid medication dose at home. In addition, our results may not be generalisable to other countries. This study was conducted at five sites across England, where results for each site varied depending on the sociodemographic population as well as the health services provided to support parents and patient medication administration at home. Finally, our health literacy assessment relied on participant comprehension of written health information and dismissed other health literacy skills such as verbal comprehension. Therefore, future studies are recommended where a larger sample size is recruited, in addition to gathering more information about the socio-demographic characteristics of the parents and children (parent's level of education, number of children, if the child has an acute or chronic illness and name of medication administered). Furthermore, testing parents while administering the medication to their children in real time, preferably in a home setting, as well as observing young people preparing and taking their own medication at home are recommended. This will further enrich our understanding of medication administration challenges and issues at home among this age group, per illness per medication.

5.5 Conclusion

The findings of this study demonstrated that parents and young people in England encounter issues in regards to preparing liquid medication at home. These errors vary across different liquid types (syrup vs solution). Regarding dose accuracy and its association with health literacy, our findings suggested that there was no association within the sample recruited. Further, larger scaled studies are needed to investigate the co relation between health literacy and dose accuracy. Overall, the study findings showed that there is a significant association between dose accuracy and measurement tool size, type and the dose volume measured. The results have a significant public and policy implications. Providing a closely matched measurement tool to the prescribed dose is one strategy that could reduce underdosing errors. In addition, demonstrating the dose in front of the parent or the young person could also help in reducing issues of medication administration at home, along with the verbal counselling. On a pharmaceutical level, there is a need to design a standardised measurement tool for each liquid medication that is simple to use by parents and young people.

Future research in this area at a national level is required, recruiting a larger sample size to enrich further the understanding of paediatric medication administration challenges among parents and children at home, per medical condition, per age group in England.

Chapter 6 -Conclusion and future recommendations

6.1 Overall aim of the thesis and how it's been answered

Due to the lack of data from the literature in regards to medication administration challenges among children and young people at home in the UK, the need for this project was highlighted. The project aimed at exploring the issue and reporting all published data. It was carried out by conducting an extensive systematic review, accompanied with an online survey targeting healthcare professionals, specifically pharmacists and pharmacy-related staff. Interviews targeting parents and young people followed. Finally, an observational session to assess parents' and young people's dose accuracy with liquid medications was conducted. Overall findings from the review, survey, and the interviews helped provide recommendations for an intervention to reduce medication administration errors in children and young people here in the UK.

The project provided an answer as to whether there is an issue regarding medication administration at home among children and young people. This question has been thoroughly examined in the past three years to highlight the challenges that could be used as a baseline to tackle the problem. The results presented in this thesis will help establish some areas to work on regarding medication administration problems and challenges at home among children aged 0 to 18 years old in the United Kingdom. The findings from each study emphasised the importance of collaborative work across the involved stakeholders: parents, patients, healthcare professionals, and the pharmaceutical industry and policymakers, to improve medication care at home.

The following sections will provide the reader with an overall summary which includes the aim, objective and the main findings of each project conducted during the last three years.

6.1.1 Chapter 2 the systematic review

6.1.1.1 Aims and objective of the systematic review

The systematic review aimed to identify English studies that highlighted medication administration problems experienced by parents and children; as well as identifying risk factors that contribute to the issue, such as the health literacy of the parents.

6.1.1.2 Main findings of the systematic review

From the review analysis, three themes were identified:

Theme 1: Types and causes of medication errors among paediatrics in an outpatient setting

Theme 2: Factors related to patients or caregivers and medication errors

Theme 3: Potential strategies that can help in reducing medication administration errors occurring among paediatrics in an outpatient setting

The key findings from the review:

- The review indicated that dosing errors (both underdosing and overdosing errors) are among the most common medication errors made by parents. The magnitude and frequency of dosing errors made by parents were influenced by measurement tools such as kitchen spoons, measurement cups used and the dose volume. Also, the labels and units of the prescribed medication were contributing factors for dosing errors. Finally, the type of instructions provided to parents on how to administer medication at home were considered. The review highlighted from the identified studies that using pictogram instruction as part of consultation could potentially reduce dosing errors.
- Parents' and caregivers' health literacy influence dose accuracy. The review highlighted that parents and caregivers with adequate or marginal health literacy were more likely to use a non-standardised dosing instrument and lacked the knowledge of weight-based dosing for children when compared with adults. There is an association between health literacy and measurement tool preference. Parents with limited health literacy reported that dosing cups were the tool of choice most of the time.
- Comprehension and recall of instructions in relation to parent's sociodemographic and its effect on dose accuracy. The use of simple language and pictogram instructions was associated with fewer errors of knowledge of dose frequency and dose accuracy.
- One of the potential ways to reduce dosing errors by parents is to show them how to prepare the dose along with verbal instructions. The review also highlighted the need for intensive teaching, training and coaching programmes to accommodate different parental health literacy levels.

- Finally, matching the measurement tool with the prescribed dose volume and moving towards more simplified numerical markings on the tool such as millilitre- only units could potentially help reduce paediatric-dosing errors.

From the initial literature review, the data was clear in that medication administration is amongst the common issues in regards to medication errors, and these vary across the countries. No clear information was found in regards to the nature of these problems in the UK. To fulfil the gap and increase our understanding of medication administration issues among children and young people at home in the UK, a series of research methodologies was conducted to examine and identify potential issues. This was performed through reviewing previous literature and surveying pharmacy professionals to understand their perceptive and recommendations on this issue based on their experience. As well as interviewing parents and young patients, to highlight the real challenges they encounter on a daily basis at home, parents and young people were observed preparing a pre-set of liquids to quantify the findings further and extrapolate the problems. The systematic review looked at medication administration issues among children and identified the causality factors for these errors. The review results showed that medication administration issues are a global issue, and to optimise medication further research is needed to address these issues from the parents' and patients' perspectives. Consultation time between parents and healthcare professionals is a key contribution to optimising treatment at home. The sociodemographic characteristics of parents and patients such as health literacy and language were identified as key factors to incorporate while designing future interventions aiming at reducing medication administration issues at home among children and young people. In addition, the systematic review findings helped with the methodological design of the (REMEDY) study.

6.1.2 Chapter 3 The NPPG survey- a survey with pharmacy team members

6.1.2.1 Aims and objectives of the NPPG survey

The survey aimed to ascertain the current challenges and obstacles that patients, parents or caregivers face during medication administration in children and young people aged between 0 to 18 years old outside a clinical setting from a healthcare professional's perspective in particular pharmacists.

6.1.2.2 Main findings of the NPPG survey

The sample recruited was from different geographical areas in the UK as well as outside the UK. Therefore, it gave an insightful perspective from healthcare professionals into the concerns and challenges that parents experience while administering medication.

Theme 1: Pharmacy professionals' concerns and expectations regarding medication administration carried out by parents for children at home

Theme 2: Pharmacy professionals' recommendations to support parents while administering medication to their children

Key findings from the survey:

- Dosage form preference among this age group: the respondents expressed that liquid dosage forms are most often used for various reasons (preference by the patient or the staff, easy to administer, tolerability and dose precision purposes); injections are also often used especially in critical care areas or acute treatment.
- Measurement tool that is the most commonly used: the respondents indicated that oral syringes are the common tool dispensed because they make it easy to measure the dose accurately and helpful with smaller children in preventing spillage. They are available in different volume sizes.
- From the pharmacy team's perspective, the parents are considered primarily responsible for ensuring that the child is receiving all of their medication. When the child`s age is appropriate, parents should discuss with the child the medication administration process.
- The most extremely challenging age group to administer medication to among children is neonatal (0 to 28 days), and that is due to the lack of suitable formulations, medication volume and insufficient information to support the medication choice.
- The respondents provided a list of concerns, which varied between age groups. Concerns were related to formulations, dose availability, taste, the suitability of the preparation, the ability of parents and caregivers to administer the dose correctly and not to be confused

between the volume that needs to be administered and the strength of the medication and compliance.

- Pharmacy professionals` indicated that counselling time is a key factor that could help parents` understand how to administer medication correctly. In addition to that, training and educational materials for patients and parents are a priority.
- From the respondents' clinical experience, they have listed the main challenges that parents face with medication administration to their children. Among these challenges are the ability of the parents to understand a complex regimen and administration information provided to them; as well as making sure that the child is taking the medication, especially if it has unpleasant taste.

The NPPG survey was a pilot study to help investigate the problem from a health care professional's perspective. The registered pharmacists in this group gave an overall idea based on their experience and practice here in the UK and provided recommendations and strategies on how paediatric medication administration could be optimised at home. This survey`s findings showed that counselling and educational tools are essential to improve medication administration at home.

6.1.3 Chapter 4 Interviews with parents and young people-REMEDY phase one

6.1.3.1 Aims of REMEDY phase one

This study aimed at identifying via interviews the specific problems and challenges of medication administration that occur among children and young people at home, from a parent's or patient's perspective.

6.1.3.2 Main findings of REMEDY phase one

- Three main themes were identified from the interviews, and the overall key findings from these themes are summarised below.

- There were problems that are related to the medication itself, which is associated with patient preference and the child's health issue. Parents expressed that they struggle to administer tablet medications, and that this problem was not only experienced with small children but also with younger people aged 15 and 16 years old.
- The taste of the medication is something that parents struggle with, and they need to use a lot of persuasion techniques with their children to administer an unpleasant medication. Antibiotics are among the problematic medications to administer, as reported by the interviewed parents.
- Tablet crushing is another challenging issue to parents as it's inconvenient and time-consuming, mostly if it's done more than once a day. Parents expressed that more detailed instructions and information is needed on how to crush a tablet.
- Insufficient, unclear, or inconsistent medication administration instructions was a commonly reported issue by the parents.
- Parents rely on doctor's instructions when they administer the medication at home.
- Parents made some recommendations to help them be more confident while administering the medication at home to their children. Among these proposals is improving the instructions provided with the medication, and providing techniques on how to mask the taste of unpleasant medications.

In the final mixed-method two-phase study, parents and young people were recruited to discuss their current medication administration challenges. The interviews were done at five sites across England. The results from the interviews suggested that when it comes to medications, there is a need for engaging parents and patients in the decision of choosing the optimal medication formulation, as well as a need to optimise counselling strategies between parents and healthcare professionals. They also provide us with the key medication administration challenges that are divided into medication-related problems, instruction-related problems, and health issues' problems.

6.1.4 Chapter 5 Observational sessions with parents and young people- REMEDY phase two

Finally, the observation sessions provided a clear demonstration of liquid medication administration problems among parents of children aged 0 to 18 years old and young people in the England. This phase resulted in future recommendations related to counselling, medication formulations and measurement tools.

Although the aim of the studies was to identify medication administration problems among children and young people in light of health literacy, and has been fulfilled across all the studies; however, the (REMEDY) study in particular showed there was a clear association between health literacy and medication administration problems.

6.1.4.1 Aims of REMEDY phase two

6.1.4.2 Main findings of REMEDY phase two

- Dosing accuracy was an issue when parents were asked to measure both syrup and solution liquids.
- Dose accuracy was associated with the liquid type tested, more dosing errors were seen with syrup compared to solutions.
- Health literacy was not associated with dose accuracy.
- Measurement tool size and type are associated with dose accuracy, and it varied from syrup liquid type to a solution liquid type and from one volume dose to another.

This second phase was designed to assess the dose accuracy of some of the UK's parents and young people and whether there is an association with health literacy and measurement tools. In addition, it was used to determine the risk factors that may affect parents' and young people`s dosing ability, and give a better understanding of the nature of these dosing problems and challenges occurring at home outside a clinical setting.

In conclusion, medication administration issues among children and young people do exist, and this project has proved that it's also an issue here in the UK. Future studies are still needed to enrich our understanding of these problems, as well as to establish data that could use to influence policymakers

and stakeholder to implement the suggestions and techniques found from this project as well as from future work.

Overall, this project identified the main medication administration challenges among children and young people that have been addressed globally. They were pinpointed this through the conducted systematic review, which resulted in highlighting that there is no reported information on what are the challenges in the UK ,as well as the need to shed light into medication administration challenges among young people aged 16 to 18 years old. The survey results gave an insight into the pharmacy professional's perspective of this issue. This project answered whether a current problem exists in the England and provided a base for future research in this area were parents and young people are involved.

6.2 Future recommendations for potential research in this area

The study highlighted that issues in regards to medication administration at home exist and they vary in nature. From the conducted studies in this project, findings suggested some future recommendations and practical areas that could be focused on for either future research purposes to enrich understanding on the issues, or to test its applicability in both community pharmacies and hospitals. One of these recommendations includes counselling, as it was evidenced that parents struggle with instructions, which leads them to administer the medication to the child at home inaccurately. Previous studies, as well as this study, showed the importance of demonstrating the dose for the parent or the child. This includes showing how to prepare the dose intended for the child, and could also include: how to crush a tablet; emphasising the need to shake liquid suspensions (syrup) before use; how to use the measurement tool dispensed with the medication; what to do in the case of a dose being spat out; and other specific challenges to the particular parent. Training parents /caregiver as well as young people specifically who are on a chronic medication is a crucial initial step. Based on the quantitative and qualitative phases, one-to- one training in particular caregivers or young people demonstrating the preparation of the liquid medication to a HCP would be recommended. This will help to cover specific concerns and questions raised by caregivers or young person in regards to medication administration. Also will help the HCP to be able to counsel

the parents and young people based on their health literacy levels. The training process could be done by a healthcare professional on site (e.g. a nurse or a pharmacists) before discharge; to ensure that dose accuracy is achieved, as well as, any questions and concerns by the young person or their families are answered. The initial alarming results of liquid medication dose inaccuracy was shared by DD to one of the collaborator sites, along with potential solution to this problem such as dose demonstrating. Upon the advice, the site allocated a training station on the cardiology word; the station included syringes and water in a medication bottle to mimic the real experience of preparing a liquid medication at home. The parent or the caregiver will practice withdrawing the amount of liquid that has been prescribed to their child whenever they are free, and demonstrate it in front of a nurse or other available healthcare professional on the word. This practice was a success and parents and caregivers were confident to administer the medication at home. This could be a potential focal point for research to assess its applicability in a real setting and in a wider scale. Further research focusing at specific challenges for younger people aged between 16 to 18 years old, including participants on chronic medication and complex regimens; for example, adherence to their medication and medication administration management at home.

The research team is planning to apply for NIHR grant (patient benefit related research category) to further investigate the problem of medication administration among children and young people at home.

The results from the studies could be used as a guidance for any potential study looking at medication administration problems at a home setting among children and young people outside England, e.g. internationally or worldwide. There might be a slight variations in the findings from one setting to another due to certain practice regulations and services implemented in each setting, for example the level of support provided for parent and child to assist them with medication administration at home from healthcare professionals/signposted information sources.

Recommendation for future studies and research would be that researchers in medicines for children as well as the pharmaceutical companies that produce medications for use in the paediatric population would benefit from input from parents, caregivers and young patients to see if the formulations and

dosage forms could be manufactured to be user friendly and minimise potential problems at an earlier stage before a product is manufactured. In terms of healthcare professionals, the awareness of medication problems with medicines administration at home would need to be raised, as well as service development projects that would look at how to improve medication use at home for children taking medicines at home and how best to support parents administering medicines to their child.

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Appendixes

Appendix A: Registered protocol of the systematic review on PROSPERO:

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Medicine use and optimisation for paediatric patients – medication administration and adherence of parents

Dania Dahmash, Zakia Ramjee, Daniel Kirby, David Terry, Chi Huynh

Citation

Dania Dahmash, Zakia Ramjee, Daniel Kirby, David Terry, Chi Huynh.
Medicine use and optimisation for paediatric patients – medication administration and adherence of parents

. PROSPERO 2018 CRD42018091590 Available from:
https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018091590

Review question

To systematically review all published evidence that are related to medication administration accuracy and its relation in improving medication adherence among the paediatric population.

Including, to:

1- Identify the main issues and challenges that the patient or their parents, caregivers or healthcare professionals face when administrating or taking a medication.

2- Evaluate the health literacy and knowledge of parents, caregivers or healthcare professionals concerning medication administration.

3- Identify any published methods or tools that improves mediation administration accuracy among the paediatric population. If so does this method improves medication adherence to paediatric population?

4- Identify how medication adherence among paediatric population is measured.

Searches

The search of the literature was initiated on 1st November 2017 and updated on the 1st of September 2020 and the following electronic bibliographic databases were screened and included:

PubMed

Scopus

Web of Science

Cochrane Library

The above will be accompanied with searching the grey-literature and this will include any related statistics on the topic, news, policy documents and conferences. The following websites will be searched:

OpenGrey

Google

NHS Digital Department of Health Office for National Statistics

BBC News

Bielefield Academic Search Engine (BASE)

E-thesis Online Service (EThOS)

Conference proceedings through Web of Science

Types of study to be included

All types of studies will be included.

Exclusion studies characteristics: non-paediatrics studies or studies with mixed data from both paediatric and adults that have no clear age stratifications.

Condition or domain being studied

Medication administration accuracy in paediatrics, including any type of medical conditions and medications dosage (e.g. tablets, capsules, injections, inhalers etc.).

Participants/population

Inclusion: children aged from 0- up to 18 years of age who are prescribed medication that requires administration by the parent, caregiver or themselves.

Exclusion: adults (over 18 years old). Children who are not prescribed any medication.

Intervention(s), exposure(s)

Exposure: This includes studies reporting medication related problems outside clinical setting, where the parent or the child is responsible in administering or taking the medication. Studies must have assessed the health literacy levels of the participants using a validated health literacy assessment tool.

Intervention: the review will include all studies that reported, identified and evaluated an intervention for improving medication administration among parents/caregivers and healthcare professionals.

Comparator(s)/control

This is a review that will include both quantitative and qualitative studies, and as such a control arm is not applicable.

Main outcome(s)

This review will aim at reviewing the current available published studies that report medication administration issues in the context of health literacy within the defined age range .

* Measures of effect

Not applicable

Data extraction (selection and coding)

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PROSPERO

International prospective register of systematic reviews

A preliminary screening of the title or abstract of all studies identified using the above-mentioned search strategy will be undertaken by DD to exclude any non-relevant studies. Afterward, an additional review by two reviewers, working independently (DD and ZR) will be undertaken using a defined structured checklist to further refine the available listing. The reviewers DD and ZR will consider any potentially relevant studies by reviewing the full text articles independently of each other for eligibility, data extraction and analysis. Any disagreements between the reviewers regarding inclusion or exclusion of a particular study will be resolved through reviewing the study full text, followed by further discussion between reviewers and in the attendance of a third reviewer if necessary.

All non-English and non-full text studies will be excluded. Then all the titles or abstracts will be screened, based on whether the study is reporting any administration medication errors, issues and challenges among paediatric patients or not. In addition, studies will be screened if they contain any information about the role of parents/caregivers and healthcare professionals in improving medication administration or their knowledge and health literacy concerning medication administration. References listed within included studies will be considered to identify any further studies to be included in the review.

For data extraction, a spreadsheet using MS-Excel 2010® will be developed and populated with study details. Two reviewers DD and ZR working independently will highlight which studies in the spreadsheet meet the final entry criteria. Afterward, the two spreadsheets will be compared and a final data sheet will be agreed. Any discrepancies found will be considered until consensus is reached or referred to a third reviewer. Authors will be contacted for any missing data if necessary.

Risk of bias (quality) assessment

Two reviewer DD and ZR will independently assess the risk of bias among the included studies using the "Critical Appraisal Skills Programme" (CASP) checklist. Any discrepancies found will be considered until consensus is reached or referred to a third reviewer.

Strategy for data synthesis

Results and findings from the included studies will be presented in a narrative report. Each study in the final review will be summarised by obtaining the following information: participant characteristics including (age and gender); setting and country of the study; methods characteristics of the study (study design, duration, inclusion and exclusion criteria, intervention, comparison group and main outcomes and findings); the presence and the use of any medication administration tool that improved medication administration accuracy; any challenges facing the parents/caregivers and healthcare professionals with medication administration to paediatrics; and if there is any information regarding health literacy of parents/caregivers.

Analysis of subgroups or subsets

Analysis of the subgroups will depend on the findings.

Contact details for further information

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Organisational affiliation of the review

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Dr David Terry. Aston University
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Type and method of review

Systematic review

Anticipated or actual start date
01 November 2017

Anticipated completion date
01 September 2020

Funding sources/sponsors
Funding provided by Aston University, Birmingham, United Kingdom

Conflicts of interest

Language
English

Country
England

Stage of review
Review Completed not published

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Child; Humans; Medicine; Parents; Pharmaceutical Preparations

Date of registration in PROSPERO
23 March 2018

Date of first submission
19 March 2018

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes
Formal screening of search results against eligibility criteria	Yes	Yes
Data extraction	Yes	Yes
Risk of bias (quality) assessment	Yes	Yes
Data analysis	Yes	Yes

Revision note
There is no major changes to the initial submitted protocol, just further clarifications to some sections and updating the progress of this review.

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.

Appendix B: The ethical approval application for the survey (Aston university ethical approval committee)

PhD Student Ethics Application 1340

Submitted by dahmashd on Fri, 2018-04-20 13:48

Section A

A1	Title Of Research (max 20 words):	A Survey of Members of the Neonatal and Paediatric Pharmacists Group concerning Medication Administration Issues to Children and Young Adults aged 0-18 Years Old
A2	Proposed Study Dates: Start Date	1 August 2018
A3	Proposed Study Dates: Finish Date	30 November 2018
A4	*Project Supervisor details:*	
A4a	Project Supervisor details: Title and Name	Dr David Terry
A4b	Project Supervisor details: Email Address	d.terry@aston.ac.uk
A4c	Project Supervisor details: Telephone	+44 (0) 121 204 3006
A5	School	
A6	*Student details:*	
A6a	Student details: Name	Dania Dahmash
A6b	Student details: Email Address	dahmashd@aston.ac.uk

Section B

Link to uploaded University Risk Assessment Form in PDF format:

B - Upload	No file uploaded	
B1	Does the project involve participants selected because of their links with the NHS/clinical practice or because of their professional roles within the NHS/clinical practice, or does the research take place within the NHS/clinical practice, or involve the use of video footage or other materials concerning patients involved in any kind of clinical practice ?	Yes
B2	Does the project involve any i) clinical procedures or ii) physical intervention or iii) penetration of the participant's body or iv) prescription of compounds additional to normal diet or other dietary manipulation/supplementation or v) collection of bodily secretions or vi) involve human tissue which comes within the Human Tissue Act? (eg surgical operations; taking body samples including blood and DNA; exposure to ionizing or other radiation; exposure to sound light or radio waves; psychophysiological procedures such as fMRI, MEG, TMS, EEG, ECG, exercise and stress procedures; administration of any chemical substances)?	No
B3	Having reflected upon the ethical implications of the project and/or its potential findings, do you believe that the research could be a matter of public controversy or have a negative impact on the reputation/standing of Aston University?	No
B4	Does the project involve interaction with or the observation of human beings (either directly or remotely eg via CCTV or internet interactions) , including interactions, observations, surveys, questionnaires, interviews, blogs, etc ?	Yes/Not Sure

Section C

C1	Will individual or group interviews/questionnaires discuss any topics or issues that might be sensitive, embarrassing or upsetting, or is it possible that criminal or other disclosures requiring action could take place during the study (eg during interviews/group discussions, or use of screening tests for drugs)	No
C2	*Does the project involve the deliberate selection of participants from vulnerable groups:*	
C2a	Children (ie people under the age of 18)?	No
C2b	People with learning difficulties?	No
C2c	People with mental disabilities	No
C2d	Prisoners/detained persons	No
C2e	Aston students or staff	No
C2f	People with physical disabilities	No/Not Relevant
C2g	People over 65 years of age	No/Not Relevant

C2h	Pregnant women	No/Not Relevant
C2i	Other vulnerable group	No/Not Relevant
	If Yes to C2i, please specify:	
C3	Does the research involve the deliberate deception of the participant?	No
C4a	Does the research involve the observation and/or recording (eg video, audio, CCTV, etc) of people?	No
	If you have answered "Yes/Not Sure" to answer C4a, Please answer Question C4b, otherwise please go to Question C5	
C4b	Will any people being observed and/or recorded not be informed that the observation and/or recording is taking place?	No
C5	Does the research involve the collection of confidential data and/or is there a risk that any participant could be identified from the data collected?	No

Section D

D1	Research Protocol: provide a summary of the purpose, design and methodology of the planned research, including a brief explanation of the theoretical framework that informs it. A clear statement should be included of what will happen to participants (including, where appropriate, frequency, duration and in what order). No more than 1000 words.	
	1- Summary of the Study The study aims at surveying a special interest group called the Neonatal and Paediatric Pharmacists Group (NPPG) about the main issues and challenges concerning medication administration to children aged 0-18 years old. This group consists of UK registered paediatric pharmacists, pharmacy technicians, dispensers and other pharmacy staff who have chosen to join this group – for networking, training opportunities as well as sharing best practice and furthering the knowledge of pharmacy professionals working in the paediatric pharmacy sector. Medication administration errors for children occur frequently. The most common administration error being a 10 fold overdose error (Ghaleb, Barber et al. 2006). Also, lots of children do not take their medicines as prescribed. This survey will ask pharmacy staff who look after children in hospitals about these issues. An online questionnaire using Bristol Online Survey® (BOS), will be sent to members of NPPG. The questionnaire will be sent as a link via email to the NPPG secretary and the secretary will circulate it to their members in two stages. First stage for 30 people to try the survey, then later, after any changes have been made the survey will go to the entire group. The participants have one month to complete the questionnaire if they wish to be part of this study. Results will be considered and any important findings will be made know to NPPG and other important groups looking after children.	

First stage for 30 people to try the survey, then later, after any changes have been made the survey will go to the entire group. The participants have one month to complete the questionnaire if they wish to be part of this study. Results will be considered and any important findings will be made know to NPPG and other important groups looking after children.

2-Purpose and design
The purpose of this study is to identify the issues regarding medication administration to children and young adults aged 0-18 years old. Ultimately this will help the research team identify changes in the future that may reduce medication administration problems for children.An online questionnaire will be generated using Bristol Online Survey® (BOS). The questionnaire will be sent to members of Neonatal and Paediatric Pharmacists Group (NPPG). NPPG is the only UK group that consists of pharmacists, pharmacy technicians, dispensers and other pharmacy related staff that work with the paediatric population. Upon obtaining ethical approval for the study the researcher will contact the NPPG professional secretary. They will act as a conduit for NPPG approval and to distribute the survey to their membership. Initially 30 members will be selected randomly for piloting the survey and then after any modifications, to the entire group. The database is owned and managed by NPPG who adhere to GDPR regulations. Participants (NPPG members) will be sent a link that contains a consent form along with the Participant Information Leaflet to inform their choice as to whether to take part in the study, or not. Upon clicking the yes button at the end of reading the first two pages of the attached link that includes-both Participant Information Leaflet and the consent form,afterward the participant can access the survey. If the participant didn't click the yes button the participant wont be able to access the survey nor participant in the study. The link of the survey which include: Participant Information Leaflet, consent form and the survey questions will be circulated to the NPPG member by the (NPPG) secretory. A reminder email will be sent out to all respondents on week 2+ after the initial email was sent. The survey will include both open and close questions. For data analysis, MS-Excel 2010 ® and Statistical Package for the Social Science 23® will be used.

3- Recruitment
The reason for recruiting members of the NPPG is because its a professional group, consists of pharmacists, pharmacy technicians, dispensers and other pharmacy related professional staff that provide healthcare to children. The Research Team have experience of working with this group - Huynh C, Jani Y, Wong I, Dewchand B, Tomlin S. What is the current practice of medicines reconciliation in children nationally in the UK? International Journal of Pharmacy Practice. 2013;21:62-65.
https://doi.org/10.1111/j.2042-7174.2012.00218.

Membership recruitment is further detailed on the NPPG website linked here:
http://www.nppg.scot.nhs.uk/about/

3- Inclusion / exclusion
Only members of the NPPG will be invited to be part of the study - all are pharmacy professionals.

4- Consent and Participant Information Leaflet
A consent form and Participant Information Leaflet will be part of the circulated survey. The participants will receive an email by the NPPG secretary-the email will include a link. Upon clicking on the link, the Information Participant Leaflet will appear on the first page followed by the consent form, by clicking on the yes button the participant can gain access to the survey and join the study. The participants can exist the survey at anytime they wish.

5- Risks addressed
Risks are considered to be very low. Risk to participants (NPPG members) may include stress related to completing a survey and recalling poor or concerning incidents relating to children taking medicines. However, all members of NPPG are healthcare professionals working with, or on behalf, of children. The survey will take approximately 10 minutes to complete on-line.

	Risks are considered to be very low. Risk to participants (NPPG members) may include stress related to completing a survey and recalling poor or concerning incidents relating to children taking medicines. However, all members of NPPG are healthcare professionals working with, or on behalf, of children. The survey will take approximately 10 minutes to complete on-line. There is potential risk in the opportunity to disclose personal information. In our previous study with NPPG this did not occur. Participants will be advise to not record any patient identifiable information. There are no identified financial risks. Note: the attached study protocol include the invitation emails intended for the secretory and the participants in addition to the reminder email sample. Please refer to the appendixes of the protocol.	
Link to Supporting Papers in PDF format:		
D1 - Upload	delegation_of_duties_v1.pdf study_protocol_v.4.pdf	
D2	Location of research: (enter details of all sites where research will take place and specify the elements of research to be undertaken at each centre)	
	The study is an online survey, the participant will be answering a short 10 minutes online survey upon consenting to be part of the study.	
	Procedures:	
D3a	Substances to be administered (a substance is anything other than normal food - chemical constituents of food stuffs, ethanol and variation of the diet should be included here) and method of delivery should be specified:	
	Not applicable	
D3b	If drugs are to be used, do any require clinical trials certificate or clinical trials exemption certificate?	No
If Yes, please provide a copy of the certificate (.PDF format):		
D3b - Upload	No file uploaded	
D3c	Psychological assessment:	

D3b	If drugs are to be used, do any require clinical trials certificate or clinical trials exemption certificate?	No
If Yes, please provide a copy of the certificate (.PDF format):		
D3b - Upload	No file uploaded	
D3c	Psychological assessment:	
D3d	Questionnaires: (only to be completed when project contains questionnaire(s) which fall within the types of questionnaire requiring Ethics Committee approval [see Guidelines D (3) in the ethics committee guidelines]). Indicate if the questionnaire has not yet been developed.	
	It has been developed- please see attachment. The first couple pages of the survey contains both the Participant Information Leaflet and the Consent form. The survey is designed in a way that participants cant access the survey questions if they didn't read and ticked the (YES) bottom. By clicking the YES bottom the participant consented to be part of the study and the survey questions will appear.	
Please attach ONE copy of the questionnaire:		
D3d - Upload	draft_of_the_survey-_conatins_both_participant_information_leaflet_and_consent_form.pdf	
D3e	D3e - Observation and/or Recording of People:	
	Not applicable	
D3f	Identify any procedures designed to be challenging physically or psychologically (including any physical exercise):	
	Not applicable	
D3g	Identify any new equipment to be tested:	
	Not applicable	
D3h	If this work involves human tissue does it come within the Human Tissue Act (HTA)? (If yes please consult with the Designated Individual for the HTA, currently c.j.bailey (c.j.bailey@aston.ac.uk)).	No

D4a	Number of Participants:	
	30 initially as pilot phase then the whole group will be invited to complete the survey	
D4b	Over what time span will participants be used?	
	one month	
D4c	Criteria for selection of participants:	
	Participant inclusion criteria are all member of the Neonatal and Paediatric Pharmacists Group.	
D4d	Source of participants:	
	Neonatal and Paediatric Pharmacists Group (NPPG)	
D4e	Will payments be made to the participants?	No
	If Yes, how much will each be paid?	
D4f	Are the participants patients ?	No
	If Yes state diagnosis and clinic/responsible practitioner:	
D4g	Does the study have any specific exclusion criteria for participants ?	Yes
	D4g - If Yes, on what grounds?	
	Any pharmacists, pharmacy technicians, dispensers or other pharmacy staff who are not a member of the NPPG group.	
D	*If Not Sure, explain why not:*	
D4h	Is the activity of the participant to be restricted in any way either before or after the procedure? (eg diet, driving)	No
	If Yes, Please specify duration and type(s) of restriction:	
Please attach a .PDF file containing consent form(s) and information provided to participants and to parents/guardians etc detailing how procedures and hazards are explained:		
D4i - Upload	**No file uploaded**	

D4i - Upload	**No file uploaded**	
D4j	Will all participants in the research be in a position to give informed consent ?	Yes
	If No: please explain why it is not possible to gain the participant's consent and the justification for undertaking the research without it:	
	The first couple of pages in the survey -as attached above- has both the Participant Information Leaflet and Consent form. In order to have access to the survey questions, particapnt has to read and understand both Participant Information Leaflet and Consent form then click the YES botton.	
D4k	What measures have been made for participants who might be vulnerable or might not adequately understand verbal explanations or written information given in English or have special communication needs (eg translation, use of interpreters, use of chaperones, presence of guardians, researchers from same gender as participants etc)?	
	Members of this group are active professionals of pharmacist ,pharmacy technicians ,dispensers or pharmacy related staff that are either practicing in an NHS trust or within the UK .So most of them speak English fluently as their first language or received a special training to pass an English exams to be able to practice within the UK. The non-UK members will have a good command of English in order to join the group and benefit from the resources as well as the conference – which is conducted in the English language. Hence, no language arrangement were made	
D4l	What measures have been made to ensure that any participants who are believed to be under some form of duress (eg staff, students, prisoners, members of the armed forces, employees of companies sponsoring research) are not coerced into participating	
	Not applicable	
D4m	What arrangements have been made to provide indemnity and/or compensation in the event of a claim by, or on behalf of, participants for negligent and/or for non-negligent harm? Please note that you should not undertake to provide any form of indemnity or insurance cover without first referring the matter to the Deputy Director of Finance for her/his consideration.	
	Not applicable	
Attach one PDF file containing copies of insurance certificate(s) if available:		
D4m - Upload	**No file uploaded**	
D4n	Will participants be informed that they may withdraw from the study at any time ?	Yes
	Risks and Ethical issues:	

D4n	Will participants be informed that they may withdraw from the study at any time ?	Yes
	Risks and Ethical issues:	
D5a	What do you consider to be the main ethical issues which may arise from the proposed research and give full details of any hazards, pain, discomfort, distress, inconvenience or use of deception which could affect the health, safety or well-being of any participant, or any other person who might be affected by the research. (There is no need to repeat information provided in D4 above).	
	There is a very low risk, as its an online survey with no personal data collection included in the survey. The questions are all related to their knowledge and experiences with medication administration to paediatric patients. Also, participants may exist the survey or choose not to answer particular questions at any time.	
D5b	What levels of risk are associated with these hazards?	
	Low	
D5c	How do you propose to control the risks associated with these hazards?	
D5d	What criteria have you used to determine whether the risks are acceptable?	
D5e	Is there any precedent for this research ? If so, please give details with references if possible.	
	Non	
D5f	Has this project been considered/is it being considered by any other Ethical Committee? If so, please give details and decision made. (If the project involves participants selected because of their links with the NHS, or because of their professional roles within the NHS, or the research take place within the NHS it must be must be submitted to the appropriate NHS Local Research Ethics Committee (LREC) or Multicentre REC (MREC))	
	No it has not	
Please attach one PDF file containing copies of any approval letter(s) from other Ethics Committees		
D5f - Upload	**No file uploaded**	

D5f - Upload	**No file uploaded**	
	Dissemination of Findings:	
D6a	How will the results be made available to participants and communities from which they are drawn?	
	Findings will be disseminated to the NPPG group during their annual conference, and if important findings are identified through peer-review journal publication (s).	
	Confidentiality and Data Protection:	
D7a	What measures have been put in place to ensure security and confidentiality of personal data and any video/audio recordings ?	
	No personal data will obtained from this study. The database is owned by the NPPG the PhD student will contact the NPPG secretory to identify the potential participants. The PhD student will not have any access to the database.	
D7b	Where and by whom will the data be analysed?	
	data will be anlayed using Microsoft office Excel and only the ressearcher Dania Dahmash will be analysing the data.	
D7c	Who will have access to the data generated by the study?	
	The study research team	
D7d	When will personal data and any video/audio recordings be destroyed following completion of the research ?	
	No personal data will be collected throught the study. This question is not applicable.	
	Peer Review:	
D8a	Has the quality of the research been assessed?	Yes
	If yes, then indicate how the research has been assessed (please upload copies of any referees' comments or other scientific critique reports):	
	In addition to the research team JO and OJ have been contacted to review and evaluate the study applicability. **1.Jo:is a Medicines Management Nurse working in the NHS and she represent service user.**	

Please attach one PDF file containing copies of any comments received.		
D8a - Upload	**No file uploaded**	
D9a	Please Specify Name of Sponsoring Organisation (if applicable):	
	Aston University **Aston Triangle,** **Birmingham** **United Kingdom**	
D10a	Is insurance cover provided by the sponsor ?:	**No**
D11a	*Contact Details of Other Investigators:*	
	Investigator 1: **Dr David Terry** **Pharmacy Department** d.terry@aston.ac.uk	
	Investigator 2: **Dr Daniel J. Kirby** D.J.KIRBY1@aston.ac.uk +44 (0) 121 204 3006	

Links to uploaded PDF files

D1 - Upload	delegation_of_duties_v1.pdf study_protocol_v.4.pdf
D3d - Upload	draft_of_the_survey-_conatins_both_participant_infomation_leaflet_and_concent_form.pdf

STATEMENT BY NAMED INVESTIGATORS, HEAD OF SCHOOL AND (if necessary) RESEARCH SUPERVISOR:

Appendix C: Online survey distributed to the NPPG members.

A Survey of Members of the Neonatal and Paediatric Pharmacists Group concerning Medication Administration Issues to Children and Young Adults Aged 0-18 Years Old (NPPG Study)

Participant Information Leaflet(Version: 1.0 28th of June 2018)

Purpose of the study

Medication administration errors for children occur frequently. The most common administration error being a 10 fold overdose error reported by Ghaleb, Barber et al. 2006. In addition, it has been reported that many children do not take their medicines as prescribed. Hence, further work to determine the incidence and causes of administration errors in children and young adults from a healthcare professional perspective is needed, as well as exploring the best interventions to reduce medication administration errors.

In this study, a short survey was developed to ask pharmacy staff who look after children in hospitals about these issues. To our knowledge there are no published studies regarding the opinions of healthcare professionals concerning medication administration issues among children and young adults aged 0-18 years old.

What do we need form you?

Today, we are inviting you to participant in an online survey that aim at: identifying and exploring issues encountered by pharmacy healthcare professionals regarding medication administration to children and young adults aged 0-18 years old. We would hope that with your participation and contributions to this study, you could help us find possible answers to problems that children or parents/caregivers face while taking/giving a medication.

If you decide to participate, please complete a short online survey by clicking yes button

1 / 15

in the next page. The survey should not take more 10 minutes to complete. Participation is confidential, this study has been reviewed and received a favourable opinion from the School of Life and Health Sciences Ethics Committee at Aston University.

How will the information be used?

Results will be considered and any important findings will be made know to NPPG and other important groups looking after children.

Participants who participated in the study will not be identified in any reports and their details will remain anonymous.

Contact for further information

If you have any concerns about the way in which this study has been conducted you should contact the Director of Governance, John Walter, on j.g.walter@aston.ac.uk or telephone 0121 204 4869.

If you need any further information or query about the study or would like to share any other information or idea, you can contact the chief investigator of the study at 0121-204-3941 or email the lead investigator on dahmashd@aston.ac.uk.

Again, thank you very much for your co-operation and contribution.

Many thanks and regards,

Research team

2 / 15

Consent Form

Consent Form for Participating In the Online Survey Titled

A Survey of Members of the Neonatal and Paediatric Pharmacists Group concerning Medication Administration Issues to Children and Young Adults Aged 0-18 Years Old"

Investigators: Dania Dahmash (lead investigator), Dr. David Terry (Chief Investigator), Dr. Chi Huynh and Dr. Daniel Kirby (Project co-supervisors).

Pharmacy Department, Aston University, United Kingdom.

Kindly, read the following and click the YES button at the end if you agree:

1. I have read and understood the Participant Information Leaflet (found on page one **Version: 1.0 28th of June 2018**) for the research project named above. I have had enough time to consider the information and to ask questions. I am happy with any answers I have been given.

2. I understand that I am free to withdraw from the study without giving a reason for withdrawing and without any detriment to my working arrangements.

3. I understand that data collected from the survey will be looked at by the research team, and that all information will remain anonymous and confidential, and that no personal information will be used which may identify me, my patients or any other people in the final report or scientific publications.

4. I understand that all data collected will be secured on password-protected computers in line with the Data Protection Act 1998(DPA) .

5. I understand that if any disclosures are made during the survey that suggest malpractice, misconduct, or that someone is in danger of harm, this information will be shared with the appropriate personnel.

3 / 15

6. I agree to take part in this research study.

By clicking **yes** button, you confirm that you have read the Participant Information Leaflet and you are willing to proceed with the study * *Required*

- (•) Yes
- ( ) No

4 / 15

Demographic Background

Are you a **(Tick one box only)** ✱ *Required*

- ○ Pharmacist
- ○ Technician
- ○ Dispenser

Please select one sector that you work in principally (e.g. your main employment sector)
✱ *Required*

- ○ A General Hospital
- ○ A Specialist Children`s Hospital
- ○ University
- ○ Other

If you selected Other, please specify:

How long have you been a UK registered pharmacist? ✱ *Required*

- ○ 0-3 years
- ○ 4-6 years
- ○ 7-10 years
- ○ 11-14 years
- ○ 15-18 years
- ○ More than 18 years
- ○ Not registered

5 / 15

Where do you practice ? * *Required*

- England
- Northern Ireland
- Scotland
- Wales
- Outside UK
- Not applicable

6 / 15

Dosage Forms Preference Among Paediatric Patients and How to Enhance Medication Administration Accuracy

Please **tick all** that apply regarding your role in managing a child's medication: prescription * *Required*

- ☐ Procuring
- ☐ Dispensing
- ☐ Managing unlicensed prescription
- ☐ Clinically checking medication
- ☐ Doing medication reconciliation
- ☐ Drug history taking
- ☐ Discharge medication list screening
- ☐ Counselling patients/parents/caregivers on their medication
- ☐ Other

If you selected Other, please specify:

Please describe your understanding of the role of parents/caregivers in child medication management? * *Required*

7 / 15

Please indicate your level of agreement to the statement: "parents/caregivers require training/education when it comes to medication administration" * *Required*

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

What is (are) the main concern(s) when a new medication is prescribed to a neonate aged **0-28 days**? *Optional*

What is (are) the main concern(s) when a new medication is prescribed to an infant aged **28 days-24 months?** *Optional*

What is (are) the main concern(s) when a new medication is prescribed to a child aged **2-12 years?**

8 / 15

What is (are) the main concern(s) when a new medication is prescribed to an adolescent aged **12-18 years** ? *Optional*

Does your institution have a guideline in relation to medication administration to paediatrics? If you are happy to share your Trust medication administration for children's guidelines, please send them to Ms Dania Dahmash on email: - dahmashd@aston.ac.uk

- Yes
- No

Rate the most used dosage forms for a paeditric patient in your facility? **(Tick one option per row) If this is not applicable to you go to question 14.**

Please don't select more than 1 answer(s) per row.

Please select at least 11 answer(s).

	Not at all used	Slightly used	Moderately used	Commonly used	Extremely used
Caplets	☐	☐	☐	☐	☐
Capsules	☐	☐	☐	☐	☐
Creams	☐	☐	☐	☐	☐
Injections	☐	☐	☐	☐	☐
Mini tablets	☐	☐	☐	☐	☐
Ointments	☐	☐	☐	☐	☐
Oral dispersible tablets	☐	☐	☐	☐	☐

9 / 15

Solutions	☐	☐	☐	☐	☐
Suppositories	☐	☐	☐	☐	☐
Suspensions	☐	☐	☐	☐	☐
Tablets	☐	☐	☐	☐	☐

If you have ticked extremely used in the above question please explain? * *Required*

Which is the most common measurement tool dispensed along with liquid dosage forms? * *Required*

- ○ Dosing cup
- ○ Oral syringe
- ○ Dropper
- ○ Medicine spoon
- ○ Others

If you selected Other, please specify:

Why is this tool commonly dispensed? * *Required*

10 / 15

Medication Administraion and Expert Recommendations

The following are lists of potential improvements in regards paediatric medication administration; based on your experience please rank the following in order of priority in improvement. Where 1 is the most priority and 3 is the least. * *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3
Patient information leaflets need to be more tailored to patients/parents/caregivers needs.	☐	☐	☐
Counselling time between pharmacists and patient/parents/caregivers.	☐	☐	☐
Training and educational materials to patients/parents/caregivers	☐	☐	☐

What are the main challenges that parents/caregivers face with medication administration ? * *Required*

In practical ways,how can parents/caregivers be better supported to enable them to administer medication to their children? * *Required*

11 / 15

List the most challenging dose formulations used by children? * *Required*

Which drug entities are the most challenging to administer among paediatric patients? **If possible list five chemical entities.** * *Required*

For each age group listed below tick one box to indicate how challenging medication administration for this age group. **Where 1 is extremely challenging and 5 is not challenging at all.**

Please don't select more than 1 answer(s) per row.

	1	2	3	4	5
Neonate (0-28 days)	☐	☐	☐	☐	☐
Infants (28 days - 24 months)	☐	☐	☐	☐	☐
Children (24 months-6 years)	☐	☐	☐	☐	☐
Children (6 -12 years)	☐	☐	☐	☐	☐
Adolescents (12 - 18 years)	☐	☐	☐	☐	☐

Why Do you think so?

12 / 15

Please use the box below to add further recommendations about medication administration to paediatrics? * *Required*

13 / 15


The End
15 / 15

Thank You!

Thank you very much for your co-operation and contribution

14 / 15

Appindix D: IRAS aplication submited to grant approval for phase one and phase two REMED

IRAS Form | Reference: | IRAS Version 5.11

Welcome to the Integrated Research Application System

IRAS Project Filter

The integrated dataset required for your project will be created from the answers you give to the following questions. The system will generate only those questions and sections which (a) apply to your study type and (b) are required by the bodies reviewing your study. Please ensure you answer all the questions before proceeding with your applications.

Please complete the questions in order. If you change the response to a question, please select 'Save' and review all the questions as your change may have affected subsequent questions.

Please enter a short title for this project (maximum 70 characters)
Realising the issues of medicine administration to the young (REMEDY)

1. Is your project research?

◉ Yes ○ No

2. Select one category from the list below:

○ Clinical trial of an investigational medicinal product
○ Clinical investigation or other study of a medical device
○ Combined trial of an investigational medicinal product and an investigational medical device
○ Other clinical trial to study a novel intervention or randomised clinical trial to compare interventions in clinical practice
○ Basic science study involving procedures with human participants
◉ Study administering questionnaires/interviews for quantitative analysis, or using mixed quantitative/qualitative methodology
○ Study involving qualitative methods only
○ Study limited to working with human tissue samples (or other human biological samples) and data (specific project only)
○ Study limited to working with data (specific project only)
○ Research tissue bank
○ Research database

If your work does not fit any of these categories, select the option below:

○ Other study

2a. Please answer the following question(s):

a) Does the study involve the use of any ionising radiation?	○ Yes	◉ No
b) Will you be taking new human tissue samples (or other human biological samples)?	○ Yes	◉ No
c) Will you be using existing human tissue samples (or other human biological samples)?	○ Yes	◉ No

3. In which countries of the UK will the research sites be located? *(Tick all that apply)*

☑ England
☐ Scotland

Date: | 1 | 258491/1316350/37/519

☐ Wales
☐ Northern Ireland

3a. In which country of the UK will the lead NHS R&D office be located:

◉ England
○ Scotland
○ Wales
○ Northern Ireland
○ This study does not involve the NHS

4. Which applications do you require?

☑ IRAS Form
☐ Confidentiality Advisory Group (CAG)
☐ Her Majesty's Prison and Probation Service (HMPPS)

Most research projects require review by a REC within the UK Health Departments' Research Ethics Service. Is your study exempt from REC review?

○ Yes ◉ No

5. Will any research sites in this study be NHS organisations?

◉ Yes ○ No

5a. Are all the research costs and infrastructure costs (funding for the support and facilities needed to carry out research e.g. NHS Support costs) for this study provided by a NIHR Biomedical Research Centre, NIHR Collaboration for Leadership in Health Research and Care (CLAHRC), NIHR Patient Safety Translational Research Centre or Medtech and In Vitro Diagnostic Cooperative in all study sites?

Please see information button for further details.

○ Yes ◉ No

Please see information button for further details.

5b. Do you wish to make an application for the study to be considered for NIHR Clinical Research Network (CRN) Support and inclusion in the NIHR Clinical Research Network Portfolio?

Please see information button for further details.

○ Yes ◉ No

The NIHR Clinical Research Network provides researchers with the practical support they need to make clinical studies happen in the NHS e.g. by providing access to the people and facilities needed to carry out research "on the ground".

If you select yes to this question, you must complete a NIHR Clinical Research Network (CRN) Portfolio Application Form (PAF) immediately after completing this project filter question and before submitting other applications. Failing to complete the PAF ahead of other applications e.g. HRA Approval, may mean that you will be unable to access NIHR CRN Support for your study.

6. Do you plan to include any participants who are children?

◉ Yes ○ No

7. Do you plan at any stage of the project to undertake intrusive research involving adults lacking capacity to consent for themselves?

○ Yes ◉ No

Answer Yes if you plan to recruit living participants aged 16 or over who lack capacity, or to retain them in the study following loss of capacity. Intrusive research means any research with the living requiring consent in law. This includes use of identifiable tissue samples or personal information, except where application is being made to the Confidentiality Advisory Group to set aside the common law duty of confidentiality in England and Wales. Please consult the guidance notes for further information on the legal frameworks for research involving adults lacking capacity in the UK.

8. Do you plan to include any participants who are prisoners or young offenders in the custody of HM Prison Service or who are offenders supervised by the probation service in England or Wales?

○ Yes ◉ No

9. Is the study or any part of it being undertaken as an educational project?

◉ Yes ○ No

Please describe briefly the involvement of the student(s):
This project is fully funded by Aston university as part of the Principal Investigator(Dania Dahmash) PhD scholarship. The student will undertake all activities in regards to the study and this will include: interviews, observations and analysis of the findings.

9a. Is the project being undertaken in part fulfilment of a PhD or other doctorate?

◉ Yes ○ No

10. Will this research be financially supported by the United States Department of Health and Human Services or any of its divisions, agencies or programs?

○ Yes ◉ No

11. Will identifiable patient data be accessed outside the care team without prior consent at any stage of the project (including identification of potential participants)?

○ Yes ◉ No

Integrated Research Application System
Application Form for Research administering questionnaires/interviews for quantitative analysis or mixed methodology study

IRAS Form (project information)

Please refer to the E-Submission and Checklist tabs for instructions on submitting this application.

The Chief Investigator should complete this form. Guidance on the questions is available wherever you see this symbol displayed. We recommend reading the guidance first. The complete guidance and a glossary are available by selecting Help.

Please define any terms or acronyms that might not be familar to lay reviewers of the application.

Short title and version number: (maximum 70 characters - this will be inserted as header on all forms)
Realising the issues of medicine administration to the young (REMEDY)

Please complete these details after you have booked the REC application for review.

REC Name:

REC Reference Number: **Submission date:**

PART A: Core study information

1. ADMINISTRATIVE DETAILS

A1. Full title of the research:

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

A2-1. Educational projects

Name and contact details of student(s):

Student 1

	Title	Forename/Initials	Surname
	Mrs	Dania	Dahmash
Address	73 Viva		
	10 Commerial Road		
	Birmingham		
Post Code	B1 1RH		
E-mail	dahmashd@aston.ac.uk		
Telephone	07392562725		
Fax			

Give details of the educational course or degree for which this research is being undertaken:
Name and level of course/ degree:

Doctor of Philosophy (PhD), Second year

Name of educational establishment:
Aston University, Birmingham, West Midlands.

Name and contact details of academic supervisor(s):

Academic supervisor 1

	Title	Forename/Initials	Surname
	Dr	Chi	Huynh
Address	Aston University		
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	Birmingham		
Post Code	B4 7ET		
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Academic supervisor 2

	Title	Forename/Initials	Surname
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Address	Aston University		
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Academic supervisor 3

	Title	Forename/Initials	Surname
	Dr	David	Terry
Address	Aston University		
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	Birmingham		
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Please state which academic supervisor(s) has responsibility for which student(s):
Please click "Save now" before completing this table. This will ensure that all of the student and academic supervisor details are shown correctly.

Student(s)	Academic supervisor(s)
Student 1 Mrs Dania Dahmash	☑ Dr Chi Huynh ☑ Dr Daniel J. Kirby

☑ Dr David Terry

A copy of a current CV for the student and the academic supervisor (maximum 2 pages of A4) must be submitted with the application.

A2-2. Who will act as Chief Investigator for this study?

○ Student
◉ Academic supervisor
○ Other

A3-1. Chief Investigator:

	Title	Forename/Initials	Surname
	Dr	Chi	Huynh
Post	Lecturer in Clinical Pharmacy, Undergraduate Admissions Tutor – MPharm, Programme Director – Masters in Overseas Pharmacy MSc OSPAP		
Qualifications	BSc (Hons), MRPharmS, PhD, PGCert (Learning & Teaching HE), FHEA		
ORCID ID	0000 0001 6982 6642		
Employer	Aston University		
Work Address	Aston University Aston Triangle Birmingham		
Post Code	B4 7ET		
Work E-mail	c.huynh3@aston.ac.uk		
* Personal E-mail			
Work Telephone	0121 204 3231		
* Personal Telephone/Mobile			
Fax			

** This information is optional. It will not be placed in the public domain or disclosed to any other third party without prior consent.*
A copy of a current CV (maximum 2 pages of A4) for the Chief Investigator must be submitted with the application.

A4. Who is the contact on behalf of the sponsor for all correspondence relating to applications for this project?
This contact will receive copies of all correspondence from REC and HRA/R&D reviewers that is sent to the CI.

	Title	Forename/Initials	Surname
	Mr	Matthew	Richards
Address	Research Integrity Office Aston University Birmingham		
Post Code	B4 7ET		
E-mail	m.richards3@aston.ac.uk		
Telephone	0121 204 5069		
Fax			

A5-1. Research reference numbers. *Please give any relevant references for your study:*

Applicant's/organisation's own reference number, e.g. R & D (if available):	273-2018-DD
Sponsor's/protocol number:	273-2018-DD
Protocol Version:	V.0.8
Protocol Date:	07/02/2019
Funder's reference number (enter the reference number or state not applicable):	Not applicable
Project website:	

Additional reference number(s):

Ref.Number Description	Reference Number

Registration of research studies is encouraged wherever possible. You may be able to register your study through your NHS organisation or a register run by a medical research charity, or publish your protocol through an open access publisher. If you have registered your study please give details in the "Additional reference number(s)" section.

A5-2. Is this application linked to a previous study or another current application?

○ Yes ◉ No

Please give brief details and reference numbers.

2. OVERVIEW OF THE RESEARCH

To provide all the information required by review bodies and research information systems, we ask a number of specific questions. This section invites you to give an overview using language comprehensible to lay reviewers and members of the public. Please read the guidance notes for advice on this section.

A6-1. Summary of the study. *Please provide a brief summary of the research (maximum 300 words) using language easily understood by lay reviewers and members of the public. Where the research is reviewed by a REC within the UK Health Departments' Research Ethics Service, this summary will be published on the Health Research Authority (HRA) website following the ethical review. Please refer to the question specific guidance for this question.*

Medication use is an essential component of the patient healthcare cycle; however, medication errors occur frequently particularly among children and young people, commonly at the medication administration stage.

Medication errors have been defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer".

Evidence suggests that parents and informal caregivers make frequent errors when administrating medications to their children, with 50% of them having measured or administered an incorrect dose. Prior studies in paediatric health settings found that parents with limited health literacy are associated with knowledge gaps, dosing errors and poor understanding of medication labels, which can lead to errors in medication administration.

To our knowledge, little is known about the nature of medication administration issues among children and young people aged 0 to 18 years old in the UK. This project aims to identify the specific problems of medication administration to children and young people at home, from both a parent / informal caregiver perspective, as well as the experiences of young people taking medicines themselves.

Parents or informal caregivers of children aged up to 18 years, and young people aged between 16 to 18 years, who are currently in receipt of prescribed oral medication at home and are attending the hospital or are part of Aston University staff and students, will be recruited to take part in a two-phase study. During phase-one, parents or informal caregivers will be interviewed to discuss their issues regarding their children's medication, whilst young people will be interviewed to talk about their own challenges when taking medicines. In phase two of the study, participants will be invited to prepare two sets of placebo oral liquids to assess for dose accuracy.

The information obtained from the study will further enable us to ascertain types of medication administration errors occurring in the UK among children aged 0 to 18 years old and their families in a home setting, and ultimately design a model to minimise medication administration-related errors.

A6-2. Summary of main issues. *Please summarise the main ethical, legal, or management issues arising from your study and say how you have addressed them.*

Not all studies raise significant issues. Some studies may have straightforward ethical or other issues that can be identified and managed routinely. Others may present significant issues requiring further consideration by a REC, HRA, or other review body (as appropriate to the issue). Studies that present a minimal risk to participants may raise complex organisational or legal issues. You should try to consider all the types of issues that the different reviewers may need to consider.

Data Management

During the study timeframe, consent and assent forms from both study phases will be stored in a locked cupboard in a secure office within the study site. Interview transcripts, health literacy assessment papers and the observational phase notes will be stored in a locked cupboard in a secure office within the Aston University pharmacy department. Upon study completion, consent and assent forms, anonymised interview transcripts, health literacy assessment papers, observational phase notes and the study site files will be archived in the Aston University Research Archive.

Interviews will be audio recorded using an encrypted audio recording device. Once the interview audio has been transcribed, the audio will be deleted. The anonymised recordings and the observational phase notes will be transferred to an encrypted laptop owned by Aston University and backed up on a secure password-protected University network drive. To facilitate data analysis, anonymised records and notes will be backed up to a secure cloud drive owned by Aston called "Aston Box".

Interviews will be transcribed and coded at the earliest opportunity. Pseudonyms and reference numbers will be used in place of participant names to maintain anonymity during the transcribing process for the interviews and the observational notes. Data analysis will be done by the Principal Investigator (PI), and advice and support will be provided by the main supervisor (CH) and co-supervisors (DK, DT). The data will be analysed at Aston University premises.

Consent

Written consent will either be taken from the patient's parent/informal caregiver if the child is under 16 years old, or from the patient themselves if they are 16-18 years of age.

An assent form will be used where the patient is aged seven years or older and will be signed by the patient alongside the parent/informal caregiver consent form.

Age-related Participant Information Leaflets will be provided to ensure patient engagement at all ages for both phases. Participants will be provided with the Patient Information Leaflet and a copy of the interview questions. For phase one, the interview questions will be provided in advance to allow participants time to consider their possible answers and if they should wish to consent to take part in the study.

Participant Recruitment/Selection

1-Recruitment from the NHS for both phases

The hospital clinical team members will identify potential participants through inpatient or outpatient clinics; this includes clinical pharmacists and nurses in their daily ward rounds and activities. The clinical team will use patient records and medications charts, as part of their usual duties to identify potential participants.
If any of the clinical team members identify a potential participant that meets the study inclusion criteria, a copy of phase one and two Participant Information Leaflet (PIL) and the interview questions will be given to the patient if he/she is 16 to 18 years old, or to the parent or informal caregiver if the potential participant is under 16 years of age. Additionally, if the parents/informal caregivers are responsible for administering the medication to the young person aged between 16 to 18 years old, the parents/informal caregivers will be the participants and will receive a copy of the (PIL) and the interview questions by a member of the clinical team.

The (PI) will have no access to the medical record nor the medication charts, even after gaining participants` consent (parents/informal carers) and assent (child) to be part of the study.
The clinical team will introduce the Principal Investigator (PI) to the potential participant after a sufficient time has been given to allow the participant to read, understand the PIL and ask questions about the study. The PI will ask the

potential participant if they would like to be part of the study and if they have any questions regarding the study. If the potential participant agrees to be part of the study, the PI will consent (from parents/informal carers or young people) or seek an assent agreement (from the child) and recruit the participant into the study.

The above recruitment process from the NHS sites will be followed for both study phases.

2-Recruitment from Aston University for both phases

Participants will be recruited for both phases from Aston University through advertising the study using posters and Aston (staff and student) email (see supporting document for poster and email content that will be used to recruit participants). If participants contact the PI, the PI will provide the appropriate PILs for both study phases along with the interview questions. Sufficient time will be given for participants to read, understand, and ask questions about the study before consenting to take part in the study.

Additional notes for Phase Two:

All consented participants from phase one will be invited to take part in phase two.

The consent form also includes the option for participants to request a copy of the final report by providing their address, and, upon the study completion, a summary report of the findings will be shared with all study sites and to the participants who requested a copy of the results by post.

The participants will be offered, at the end of each study phase, a 10-pound voucher as an appreciation for their efforts and participation.

Disclosure of Information of Concern

Where a disclosure is made, and actions are required, the PI will seek the participant consent to discuss the information with the assisted research coordinator within the study site.
The participants will be reminded that the staff involved in this project are researchers, so any medical or clinical pharmaceutical issues will be signposted to the relevant study site coordinator.

Confidentiality

Any identifiable data during the interview and the observational phase will not be recorded, and all the information during the interview will be anonymised during the interview transcribing. Pseudonyms will be used to replace the participant name in any publications. Upon study completion, no confidential data will be stored, and anonymised data, consents/assents, transcribed interview transcripts, health literacy papers, observational phase notes and study files will be archived in the Aston University Research Archive.

Right to Withdraw

Participants will be advised that they have a right to withdraw from the study at any point.

Under GDPR, we can keep any data that they have contributed up to the point of the withdrawal. This will be covered in the Transparency wording on the PILs.

The risk associated with measuring of placebo liquids (for simulating dose preparation purposes in phase two)

There is a minimal risk of ingesting Cherry Syrup and the Normal Saline that will be used during phase two for demonstration purposes only. However, during this study phase, when parents measure the placebo liquids, any children present may pick up any of the liquids and ingest it, either because that is what they think is expected from them to do, or out of curiosity. The PI will be present throughout the measuring process taking notes, and no participant will be left alone with the liquids at any point of the process. Clear instructions will be given by the PI on how much of each placebo liquid they have to withdraw. Besides, an instruction handout will be provided at the beginning of the session (a copy of the handout is attached in protocol appendix).
Additionally, the PI will give explicit instruction regarding children who are present at the time of the session, that they are not intended to do any measuring nor touch any of the liquids. However, should any participant ingest the cherry syrup and/or the normal saline, the PI will follow the safety process that is stated within the safety data sheet of each liquid. Safety data sheets for each of the placebo liquids are enclosed as supporting documents.

Use of children in research

There is a risk of including children and young people in this research. However, to capture the problems encountered

with taking or giving medication in children: an in-depth interview and observational phase with parents or informal caregivers and young people are necessary to obtain the real problems among this particular group. Study participants including parents/informal caregivers of the child aged between 0-16 years old and young people aged between 16-18 years old will be advised that they may decline to answer any of the study questions and withdraw from the study at any time.

3. PURPOSE AND DESIGN OF THE RESEARCH

A7. Select the appropriate methodology description for this research. *Please tick all that apply:*

- ☐ Case series/ case note review
- ☐ Case control
- ☐ Cohort observation
- ☐ Controlled trial without randomisation
- ☐ Cross-sectional study
- ☐ Database analysis
- ☐ Epidemiology
- ☐ Feasibility/ pilot study
- ☐ Laboratory study
- ☐ Metanalysis
- ☑ Qualitative research
- ☑ Questionnaire, interview or observation study
- ☐ Randomised controlled trial
- ☐ Other (please specify)

A10. What is the principal research question/objective? *Please put this in language comprehensible to a lay person.*

To identify the specific problems of medication administration to children and young people at home, from both a parent / informal caregiver perspective, as well as the experiences of young people taking medicines themselves.

A11. What are the secondary research questions/objectives if applicable? *Please put this in language comprehensible to a lay person.*

To assess the degree to which the health Literacy of parents or informal caregivers and young people influences dosing accuracy of oral medication.

Health Literacy is defined as "The individuals' capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions".

A12. What is the scientific justification for the research? *Please put this in language comprehensible to a lay person.*

Medication errors frequently occur among paediatric and young people at home where parents or carers are involved in delivering the medication to their child. Medication administration-related errors have a direct impact on the child's health outcome, may delay full recovery and sometimes can end up with significant adverse events. Many studies across the globe have addressed this issue, however; there is no data in the published literature about the nature of specific medication administration-related errors among children and young people across the UK.

One recent multisite study was conducted in the US, aiming to identify types of medical errors occurring in an outpatient paediatric clinic. The study identified 136 medical errors; 56 (38%) were medical treatment errors, among which 47 (84%) errors were related to medications. This study suggested that everyone, including parents, has a role in preventing errors from reaching the child, and highlighted the importance to establish interventions to reduce medication administration-related errors.

In 2007, another USA based prospective cohort study, involving 1788 paediatric patients, was conducted in six different

paediatric outpatient clinics. The study aimed to measure the rate and the type of adverse drug events. In total, 283 errors were identified, accounting for 16% of children treated in the selected sites; 57 (3%) adverse drug events were preventable, among which 40 (70%) reported incidents were related to a parental administration error. Overall, the study suggested that improved communication between healthcare professionals and parents is essential to reduce preventable medication errors at home.

Few other observational studies have discussed medication-related incidences among children occurring at home. In one study carried out over six months, 52 homes were visited, and 280 prescriptions were reviewed. A total of 61 medication errors were identified, among which 31 errors could potentially cause injuries and nine errors resulted in an injury to the child. Communication barriers were reported to be the main reason behind those errors; in some cases, there was even miscommunication between the two parents resulting in medication administration errors in 25 (15%) cases. Furthermore, the study highlighted that medication errors were significantly reduced by 51% in children whose parents used a supporting tool to optimise medication use at home.

Another USA based study investigated the type of medication errors encountered among children diagnosed with depression. The study reported 451 medication errors; of these, 95% reached the patient. Most of the reported errors were identified at the medication administration point.

Further investigations were performed into the association of low health literacy of parents and medication errors. Kindig and his colleague defined health literacy as "The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions". Overall, parents with inadequate and marginal health literacy levels, in comparison to parents with adequate health literacy, were associated with both lack of knowledge regarding weight-based-dosing (85.3% vs 61.2%) and reporting the high use of non-standardised measuring tools (34.7% vs 19.2%). The study recommended that further intervention is needed to reduce medication administration errors among parents and caregivers from different socioeconomic backgrounds.

Another study assessed parents' and caregivers' understanding of the age indicated on over-the-counter (OTC) cold and flu medication labels. Results from this study revealed that low levels of parental health literacy increase the risk of misinterpretation of OTC products indicated for children, and it is further influenced by the language, pictures and labels used on the product, resulting in medication errors, in particular administration and dosing errors.

A study in the USA by Yin and her colleagues, who have published multiple studies in regards to dosing errors and its association with parents' inadequate health literacy, reported that low levels of health literacy are associated with dosing errors; parents with limited health literacy performed more dosing errors compared to parents with adequate literacy (161 vs 22 errors respectively) and recommend that further work is needed to address ways to optimise dose accuracy by parents.

Furthermore, recently The Department of Health and Social Life in England, in line with the WHO recommendations published a report titled "Short Life Working Group on reducing medication-related harm". The report recommended future new research on medication error should be encouraged and directed down the best avenue to facilitate positive change and further encourage and support patients and families to raise any concerns about their medication.

To our knowledge, so far there have been no published studies in the UK that have investigated the problems that parents or informal caregivers and young people have with medication administration; hence, the importance of addressing this issue through conducting an in-depth interviews and observational sessions with parents/caregivers of children aged 0-18 years old as well as with young people aged 16 to 18 years old.

A13. Please summarise your design and methodology. *It should be clear exactly what will happen to the research participant, how many times and in what order. Please complete this section in language comprehensible to the lay person. Do not simply reproduce or refer to the protocol. Further guidance is available in the guidance notes.*

1- Study design:

The study will be done in two phases, and the participants can choose to be part of phase one only or phase two only or take part in both phases.

In phase one, consented participants will have a one to one interview with the PI in a private room within the study site – for example, a booked room at Aston University, or a clinical/consultation room within the hospital sites. The interview will last up to an hour.

Participants who consented to take part in phase two will perform a task of measuring doses from written instructions; this will include measuring placebo liquids using different measurement tools, then the PI will check for dose

accuracy and record notes. Phase two will also take place in a private room within the study site (e.g. Aston University or in a hospital) The participants can do each phase in a different time or, if they wish, they can do it at the same time. Preferably, to start with phase one then phase two. The observational session will last for 30 minutes.

Little is known about the types and issues of medication administration that are encountered by young people themselves when they are taking oral medication, or with children`s parents or informal caregivers when they are giving their child an oral medication in the UK.

This study is designed to find out what are the main issues of medication administration to children encountered by the parents or informal caregivers and young people themselves. Due to the lack of information in the published literature and the need to gain an in-depth view of issues that people face in their daily lives when taking or giving medication to their children, a qualitative study using face-to-face interviews is considered to be the most appropriate study design, followed by an observational study phase to determine the extent of medication administration errors.

Overall, both phases will help in providing in-depth information regarding the nature of medication administration challenges that both parents or informal caregivers and young people experience with medication administration in children aged 0-18 years old in the UK.

2- Setting:

To have validated and generalisable data across the UK, the research team opted to have a multisite study.

The study will take place at the following sites:
1- Guy`s and St Thomas` NHS Foundation Trust (London)
2- Great Ormond Street Hospital (London)
3- Birmingham Women`s and Children Hospital NHS Foundation Trust(Birmingham)
4- Alder Hey Children`s NHS Foundation Trust (Liverpool)
5- Aston University (Birmingham)

3-Timetable of activities:

-April- September 2019: Participant recruitment, consenting potential participants (phase one and phase two), interviewing study participants, observing parents/informal caregivers and young people while preparing a predesigned dose instruction (phase two), transcribing, and coding the interviews.

-October– December 2019: Data analysis of all anonymised transcribed interviews, observational notes and health literacy papers using QSR NVivo programme.

-January- April 2020: Study final report completion.

4- Inclusion criteria:

Parents/informal caregivers of children/young people aged up to 18 years and young people aged between 16 to 18 years old who are responsible in giving/ taking the medication will be eligible for inclusion in the study.

Participants must be able to understand both written and spoken English.

5- Sample size:

For each study phase, the sample size will be as the following:

Overall, up to 15 parents/informal caregivers of patients in each of the following age groups: 0 to 5 years, 6 to 10 years and 11 to 16 years, and up to 15 young people aged between 16 to 18 years old. For qualitative research, fifteen participants are generally considered sufficient to withdraw themes.

6- Recruitment:

1- Recruiting through NHS Trust:

For both phases:

Potential participants will be identified by clinical team member undertaking their daily ward round and activities as part of the direct clinical care team. When the clinical member identifies a patient meeting the study inclusion criteria, they will provide a copy of the appropriate aged Participant Information Leaflet (PIL) and the study questions to the

patient if 16 years of age or older and the parent/informal caregiver if the patient is under 16 years. The clinical team member will introduce the study Principal Investigator (PI) to the potential participant after sufficient time is given to the potential participant to read and understand the (PIS). The PI will ask the potential participant if they would like to join the study, answer any questions that they may have prior obtaining a consent (from parents/informal caregivers or young people) or seek an assent agreement (from a child) and recruit the participant into on or both studies.

Participants consented to take part in phase one will be invited to take part in phase two and vice versa, participants who joined in phase two and weren't part in phase one will be invited to take part in phase one of this study.

2- Recruiting through Aston University:

Participants will be recruited through Aston University by distributing the study advertisement poster and via Aston staff and student email. If any potential participants are interested, and upon the contacting the PI, the PI will share the study PIL for both phases and the interview questions and allow for a sufficient time for the potential participant to read, understand the PIL and ask questions before obtaining their consent.

The data collection for both phases will occur on Aston University premises in a suitable booked room.

7- Participant Consent:

For both phases:

Written consent will be taken from the parent/informal caregiver if the child or young person is under 16 years old or if the child is aged between 16-18 years old and are dependent on their parents/informal caregivers for medication administration. Also written consent will be obtained from the patient themselves, as the study participant, if they are between 16- 18 years old. Where the parent/informal caregiver is the study participant, children/young people will be invited to contribute to the interview. An assent form will be used where the patient is aged under 16 years and can 'sign' and understand the study. This will be signed by the patient alongside the parent/informal caregiver consent form. Age-related Participant Information Leaflet will be provided to ensure patient engagement at all ages. Participants will be provided with the PIL and a copy of the interview questions. The interview questions will be provided in advance to support potential participants in their decision to take part and to allow participants time to consider their possible answers should they wish to take part in the study.

8- Data Collection:

-Phase one:
One-to-one interview between the PI and recruited parent/informal caregivers or the participants themselves if aged 16 to 18 years will be done at a convenient time for the participants and in a quiet private location. When the parents/informal caregivers are representing the participant, the child is encouraged to engage and contribute to the interview. The interview will be recorded using the Advanced Encryption Standard voice recorder. Then the interviews will be transcribed verbatim by the PI/The Typing Works Company.

Following signed consent, the PI will offer the study participants the options of being interviewed at the patient bed space/room or in a private consultation room within the hospital trust/Aston premises. The participant may choose to have other people (for example, another family member) sit in on the interview if they wish.

The interview questions will include a background related information about the parents/informal caregivers, patient-related details excluding the name (as it is not needed for the study) and medication measurement details in terms of their medication-taking activities occurring at home and outside a clinical setting.
The participants will be then asked to explain how they give any current medication (when they usually are at home without the support of a nurse – e.g. outside a hospital clinical environment) share how confident they are in following the prescribed instructions, recall their previous/current negative/positive experiences regarding medication administration.

Parents/carers and young people will be advised that they can decline not to answer any of the interview questions.

-Phase two

Upon agreement, the PI will arrange another session/same time for phase two of this study. The observational study will include written instructions and a variety of available dose measurement tools. The participants will be asked to follow the instructions given on the paper to prepare the oral liquid (placebo) formulations using the displayed measurement tools. The magnitude of dosing errors will be calculated.

The participants will have the following in front of them to use to demonstrate how they will prepare the dose:

1-Measurement tools with different volume capacity; these include cups, spoons and syringes.
2-Two liquid formulations , a representative liquid syrup (bottle A= Cherry Syrup) and a solution (bottle B= Normal Saline) liquid formulations.
3-A written handout displaying the amount of doses that they need to prepare from each bottle (see supporting document).

For the liquid formulations , the research team opted to use ready-manufactured and commercially available liquid products. For the syrup liquid formulation, Cherry Syrup will be used (See supporting document). Cherry Syrup contains 82% w/v sucrose as the main ingredient. For solution liquid formulation, normal saline will be used for the demonstration purposes. Normal saline contains water and sodium chloride as ingredients (see supporting document). The participants will not be left alone with liquid formulations under any circumstances.

For both phases:

1-During the first 7 minutes of the interview/observational phase the participants (parents/informal caregivers and young people) health literacy will be assessed using the modified standardised version of The Newest Vital Sign (NVS) tool. The assessment will include six nutritional-related-questions, and each question will be awarded one point. If the participant were part of phase one of this study, they wouldn't undergo the assessment again. (See supporting documents).
2-Participants will be advised that they can withdraw from the study at any time or decline to answer any questions.

A14-1. In which aspects of the research process have you actively involved, or will you involve, patients, service users, and/or their carers, or members of the public?

- [x] Design of the research
- [ ] Management of the research
- [ ] Undertaking the research
- [ ] Analysis of results
- [ ] Dissemination of findings
- [ ] None of the above

Give details of involvement, or if none please justify the absence of involvement.
Young people from the community have reviewed the age-specific Participant Information Leaflets.

The interview questions were piloted on a parent of a child who has been and is taking a prescribed oral medication. The parent/informal caregiver. Participant Information Leaflet was also piloted with this person.

4. RISKS AND ETHICAL ISSUES

RESEARCH PARTICIPANTS

A15. What is the sample group or cohort to be studied in this research?

Select all that apply:

- [ ] Blood
- [ ] Cancer
- [ ] Cardiovascular
- [ ] Congenital Disorders
- [ ] Dementias and Neurodegenerative Diseases
- [ ] Diabetes
- [ ] Ear
- [ ] Eye

- [x] Generic Health Relevance
- [ ] Infection
- [ ] Inflammatory and Immune System
- [ ] Injuries and Accidents
- [ ] Mental Health
- [ ] Metabolic and Endocrine
- [ ] Musculoskeletal
- [ ] Neurological
- [ ] Oral and Gastrointestinal
- [ ] Paediatrics
- [ ] Renal and Urogenital
- [ ] Reproductive Health and Childbirth
- [ ] Respiratory
- [ ] Skin
- [ ] Stroke

Gender:	Male and female participants
Lower age limit: 0	Years
Upper age limit: 18	Years

A17-1. Please list the principal inclusion criteria (list the most important, max 5000 characters).

The following inclusion criteria apply for both study phases:

A.Parent/ informal caregiver (male or female) aged 18 years old and above of a child aged 0 to 16 years old who is currently in receipt of prescribed oral medication and are responsible or share the responsibility of administering the medication to their child (0 to 16 years old).

B.Parents/informal caregivers aged 18 years old and above of a young person aged between 16 to 18 years old who are managing their child's prescribed oral medication.

C.Patients (male or female) aged 16 to 18 years old who are managing their medications, including administration of their oral prescribed medications.

D.Participants should speak English: once potential participants are identified by a member of the clinical team and introduced to the PI, the PI will assess the potential participants' level of English fluency.

Note:

An informal caregiver is defined as: the family member or another natural person who normally provides the daily care or supervision of a frail or disabled person, or any family member or other natural person who contributes to and is involved in the caretaking responsibilities for such frail or disabled person.

A17-2. Please list the principal exclusion criteria (list the most important, max 5000 characters).

The following exclusion criteria apply for both study phases:

A.Parent/informal caregiver accompanying the child but not being primarily responsible for administering the medication.

B.Non-English speakers: Only English speakers will be recruited due to limited time between approaching a potential participant by a clinical team and arranging for an interpreter.

C. Critically ill parents/informal caregivers and young people or parents/informal caregivers of a critically ill child.

D. Parents/Informal caregiver aged less than 18 years old.

RESEARCH PROCEDURES, RISKS AND BENEFITS

A18. Give details of all non-clinical intervention(s) or procedure(s) that will be received by participants as part of the research protocol. *These include seeking consent, interviews, non-clinical observations and use of questionnaires.*

Please complete the columns for each intervention/procedure as follows:

1. Total number of interventions/procedures to be received by each participant as part of the research protocol.
2. If this intervention/procedure would be routinely given to participants as part of their care outside the research, how many of the total would be routine?
3. Average time taken per intervention/procedure (minutes, hours or days)
4. Details of who will conduct the intervention/procedure, and where it will take place.

Intervention or procedure	1	2	3	4
Identification of potential participants through NHS sites by the clinical team and distributing age related PILs for both phases and the interview questions for phase one.	1	0	5 minutes	Members of the clinical team located in the study sites will identify potential participants. Study sites include: Guy`s and St Thomas` NHS Foundation Trust, Birmingham Women`s and Children`s NHS Foundation Trust, Alder Hey Children`s NHS Foundation Trust and Great Ormond Street Hospital.
Identification of potential participants through Aston University by distributing study advertisement poster and through Aston staff and student email.	1	0	2 days	The study team will distribute advertising study posters and email Aston staff and students about the study.
Assess for participant eligibility identified through Aston University	1		10 minutes	The PI will assess participants` eligibility to take part in the study for both phases.
Taking consent/assent	1	0	10 minutes	For both study phases:participants will be given a sufficient time to read demonstrate an understanding of the study and will be given an opportunity to ask any questions up to one week. The study principal investigator will go through the study again, confirm the participant wishes to join the study and take consent/assent.
Undertake the one-to-one interview	1	0	Up to 1 hour	The PI will undertake the interview in a private area within the study site. Study sites include: Guy`s and St Thomas` NHS Foundation Trust, Birmingham Women`s and Children`s NHS Foundation Trust, Alder Hey Children`s NHS Foundation Trust, Great Ormond Street Hospital and Aston University.
Undertake the observational study	1	0	Up to 30 minutes	The PI will undertake the observational study in a private area within the study site. Study sites include: Guy`s and St Thomas` NHS Foundation Trust, Birmingham Women`s and Children`s NHS Foundation Trust, Alder Hey Children`s NHS Foundation Trust, Great Ormond Street Hospital and Aston University.

A21. How long do you expect each participant to be in the study in total?

For Phase one: The interview will last approximately up to an hour. There are no further requirements for the study participant once the interview has been undertaken. If the participants express an interest in participating in phase two, an appointment will be made at a convenient time for them to attend. Consenting will be obtained for phase two separately. Phase two of this study will last up to 30 minutes.

For phase two: the observational session will take up to 30 minutes.

A22. What are the potential risks and burdens for research participants and how will you minimise them?

For all studies, describe any potential adverse effects, pain, discomfort, distress, intrusion, inconvenience or changes to lifestyle. Only describe risks or burdens that could occur as a result of participation in the research. Say what steps would be taken to minimise risks and burdens as far as possible.

During the interviews with parents and young people, participants may discuss sensitive information such as previous or current experiences with illness and medication. This has the potential to cause some level of distress to some patients. The PI will, therefore, make it clear before commencing the interview that the participants have the right to refuse to answer any question they do not feel comfortable answering, and also have the right to withdraw from the study at any point during the interview.

If at any point during the interview or the observational session, there are signs to suggest the participant is upset or distressed, the interview will be terminated. Additionally, during the observational phase, if the participants realise that they have been doing something wrong and become distressed, the session will be terminated. If the participant requires clinical advice, the PI will seek the participant consent to discuss the information with the assisted research coordinator within the study site.

The PI is trained to conduct qualitative research projects and has previously conducted qualitative interviews. The CI, who has had experience of conducting a qualitative research project as part of his PhD project, will provide mentorship and direct the PI in providing any support to participants, if required.

After the first interview and the observational session, the PI will arrange for a meeting with the CI to discuss any concerns. After this, regular debriefing sessions will be done.

Finally, the time of the interview and the observational session will be made at the convenience of the study participant and participants can opt to attend one or both phases of the study.

A23. Will interviews/ questionnaires or group discussions include topics that might be sensitive, embarrassing or upsetting, or is it possible that criminal or other disclosures requiring action could occur during the study?

◉ Yes ○ No

If Yes, please give details of procedures in place to deal with these issues:

Although the interview and the observational phase will not include topics that are sensitive, embarrassing or upsetting, it is always possible that disclosure may occur which will require action by the PI. The PI will discuss issues of disclosure with the participants before commencing with each of the study phases. If disclosure occurs, the PI will contact the site coordinator, and the appropriate actions will be taken according to the local site protocol. Further, the PI will advice the participant that they are to decline to answer any of the interview questions or refuse to do any of the dose measuring steps within phase two of this study. Additionally, the participant will be reminded by the PI they can terminate the interview and the observational phase at any point.

A24. What is the potential for benefit to research participants?

The participants may benefit from having the opportunity to discuss issues concerning their medication or their child`s medication. The participants will have the opportunity to express what are the problems they have to deal with regarding medication and how they have overcome any issues previously. This ensures that their experiences will inform prospective complex intervention, with an ultimate aim in improving medicines use in children.

Where a disclosure is made, and actions are required, the PI will seek the participants consent to discuss the information with the assisted research coordinator within the study site.

The participants will be reminded that the staff involved in this project are researchers, so if the participants during any phase of the study request clinical advice, the PI will signpost to the relevant study site coordinator. If the participants are recruited from:

1-NHS: the PI will ask the site coordinator to arrange for the participant to meet a clinical team member within the study site.

2- Aston University: the PI will ask the CI of this study to support with any clinical advice, as the CI is a qualified clinical pharmacist within the UK and held different pharmacy positions before commencing with teaching within the university.

A26. What are the potential risks for the researchers themselves? *(if any)*

The potential risks for the researcher are likely to be low. However, this is a multisite study and will be conducted by the PI. The PI will adhere to Aston University policies at all time, including Aston University Lone Working Guidance. Any distress experienced during the conduction of the study will be discussed with the Chief Investigator.

RECRUITMENT AND INFORMED CONSENT

In this section we ask you to describe the recruitment procedures for the study. Please give separate details for different study groups where appropriate.

A27-1. How will potential participants, records or samples be identified? Who will carry this out and what resources will be used?*For example, identification may involve a disease register, computerised search of GP records, or review of medical records. Indicate whether this will be done by the direct healthcare team or by researchers acting under arrangements with the responsible care organisation(s).*

For both phases:

-Potential participants are parents/informal caregivers of children aged 0-18 years old and young people aged 16-18 years old.

1- Recruitment through NHS:

Potential participants will be identified by a clinical team member undertaking their daily ward round as part of the direct clinical care team or attending outpatient's clinics. When the clinical team identifies a patient meeting the study inclusion criteria, they will provide a copy of the Participant Information Leaflet PIL for both study phases along with the interview questions. The clinical member will introduce the study Principal Investigator PI to the potential participant after sufficient time is given to the potential participants to read, understand PIL and show interest to take part in the study. The PI will ask the potential participant and patient (where they can understand) if under 16 years if they would like to join the study, answer any questions that they may have and consent/recruit them into the study if they have agreed to take part.

2- From Aston University:

Potential participants will be recruited through distributing posters and study advertisement email to the staff and students. If a potential participant is interested in taking part by contacting the PI via email, the PI will provide the appropriate PIL and give sufficient time for the participants to read, understand the leaflet and ask questions about the study before consenting the participants.

A27-2. Will the identification of potential participants involve reviewing or screening the identifiable personal information of patients, service users or any other person?

(●) Yes ( ) No

Please give details below:
Medical records will be used to identify potential participants by the clinical team.

A27-3. Describe what measures will be taken to ensure there is no breach of any duty of confidentiality owed to patients, service users or any other person in the process of identifying potential participants.*Indicate what steps have been or will be taken to inform patients and service users of the potential use of their records for this purpose. Describe the arrangements to ensure that the wishes of patients and service users regarding access to their records are respected. Please consult the guidance notes on this topic.*

Patients' in-patient medication charts and in-patient medical notes will be used to identify potential study participants by the clinical team only in the course of their usual duties.

A27-4. Will researchers or individuals other than the direct care team have access to identifiable personal information of any potential participants?

○ Yes ◉ No

A28. Will any participants be recruited by publicity through posters, leaflets, adverts or websites?

◉ Yes ○ No

If Yes, please give details of how and where publicity will be conducted, and enclose copy of all advertising material (with version numbers and dates).

1- Study posters will be distributed within Aston University campus (see supporting documents).
2- Aston student and staff will be further recruited through distributing an email regarding the study (see supporting documents).

A29. How and by whom will potential participants first be approached?

NHS sites: Potential participants will be approached first by a clinical team member located at in-patient or out-patient clinics. If the participants show interest and after a sufficient time has been given for them to read and understand the leaflet, the staff member will then introduce them to the PI.

Aston University: Potential participants will read about the study from a poster that has been distributed through the Aston campus or from an email they have received on their Aston email account. If they are interested, they can contact the PI via email (as indicated in the advertisement poster and email), the PI will provide the PIL and give sufficient time for them to read, understand the leaflet and ask questions.

A30-1. Will you obtain informed consent from or on behalf of research participants?

◉ Yes ○ No

If you will be obtaining consent from adult participants, please give details of who will take consent and how it will be done, with details of any steps to provide information (a written information sheet, videos, or interactive material). Arrangements for adults unable to consent for themselves should be described separately in Part B Section 6, and for children in Part B Section 7.

If you plan to seek informed consent from vulnerable groups, say how you will ensure that consent is voluntary and fully informed.

For those children aged under 16 years, the study participant will be the parent/informal caregiver, but children will also be welcomed to join during the interview process. Young people aged between 16 to 18 years old will be representing the study participants, and an informed consent form will be used. Children aged under 16 years will be asked for assent, where possible. Very young children under seven years may not be able to give assent. Age appropriate information leaflets have been developed (included with this application).

If you are not obtaining consent, please explain why not.

Not applicable

Please enclose a copy of the information sheet(s) and consent form(s).

A30-2. Will you record informed consent (or advice from consultees) in writing?

◉ Yes ○ No

A31. How long will you allow potential participants to decide whether or not to take part?

Up to a week; participants will be given a sufficient time to read, understand the study and will be given an opportunity to ask any questions.

A33-1. What arrangements have been made for persons who might not adequately understand verbal explanations or written information given in English, or who have special communication needs?*(e.g. translation, use of interpreters)*

Non-English speakers will be excluded from the study. Only English speakers will be recruited due to limited time between approaching a potential participant by a clinical team and arranging for an interpreter. In addition to limited resources.

A35. What steps would you take if a participant, who has given informed consent, loses capacity to consent during the study? *Tick one option only.*

- ○ The participant and all identifiable data or tissue collected would be withdrawn from the study. Data or tissue which is not identifiable to the research team may be retained.
- ○ The participant would be withdrawn from the study. Identifiable data or tissue already collected with consent would be retained and used in the study. No further data or tissue would be collected or any other research procedures carried out on or in relation to the participant.
- ○ The participant would continue to be included in the study.
- ○ Not applicable – informed consent will not be sought from any participants in this research.
- ◉ Not applicable – it is not practicable for the research team to monitor capacity and continued capacity will be assumed.

Further details:

For both phases, it will involve either a single interview or a single observational session, and they will be done soon after consent has been taken, hence, if the participants lose capacity afterwards, still the participant's data will be retained and will be used for the purposes for which consent has been given. And if during the study, if the PI felt that there are signs to suggest the participants is upset or distressed, the interview/observational session will be terminated.

CONFIDENTIALITY

In this section, personal data means any data relating to a participant who could potentially be identified. It includes pseudonymised data capable of being linked to a participant through a unique code number.

Storage and use of personal data during the study

A36. Will you be undertaking any of the following activities at any stage (including in the identification of potential participants)? *(Tick as appropriate)*

- ☐ Access to medical records by those outside the direct healthcare team
- ☐ Access to social care records by those outside the direct social care team
- ☐ Electronic transfer by magnetic or optical media, email or computer networks
- ☐ Sharing of personal data with other organisations
- ☐ Export of personal data outside the EEA
- ☐ Use of personal addresses, postcodes, faxes, emails or telephone numbers
- ☑ Publication of direct quotations from respondents
- ☐ Publication of data that might allow identification of individuals
- ☑ Use of audio/visual recording devices
- ☐ Storage of personal data on any of the following:
  - ☑ Manual files (includes paper or film)
  - ☐ NHS computers
  - ☐ Social Care Service computers
  - ☐ Home or other personal computers
  - ☑ University computers
  - ☐ Private company computers

☐ Laptop computers

Further details:
Anonymised data, including the transcribed interviews, health literacy assessment papers and the observational notes will be stored on a secured encrypted laptop owned by Aston University and backed-up on a secure password-protected University network drive. The data will be analysed by the PI and the supervisory study team.

Anonymised audio files, observational notes and health literacy assessment papers will be saved with a number to identify the file, but not anything that could identify the study participant.

Anonymised audio files, observational notes and health literacy assessment papers will only be transcribed by the study PI/The Typing Works Company. Following transcription, the audio file (the interviews) will be deleted.

Any direct quotes from participants will be anonymised in the final report and any publications.

A37. Please describe the physical security arrangements for storage of personal data during the study?

Completed consent forms and assent forms will be stored in a locked cabinet located in a secure office within each study site.

No identifiable information will be asked for during the participant interview nor the observational phase. Any identifiable information mentioned by participants will not be recorded or will be anonymised during the transcription process.

An encrypted dictaphone will be used to record all interviews. The dictaphone that will be used is in line with the NHS dictaphone requirements.

Anonymised transcribed interviews, observational notes and health literacy assessment papers will be stored on an encrypted secured laptop owned by Aston University and backed-up on a secure password-protected University network drive. Further, to facilitate data analysis, anonymised recordings will be backed up to a secure cloud drive owned by Aston called "Aston Box".

A38. How will you ensure the confidentiality of personal data?*Please provide a general statement of the policy and procedures for ensuring confidentiality, e.g. anonymisation or pseudonymisation of data.*

Any information provided during the interview and the observational phase will be anonymised at the earliest opportunity following the participant interviews and observational session.

Pseudonyms will be used in place of participant names in the final report and any publications.

All recorders will be downloaded to an encrypted secured laptop only accessible by the PI and will be transcribed as soon as possible. After transcription is completed, the audio record will be deleted.

A40. Who will have access to participants' personal data during the study? *Where access is by individuals outside the direct care team, please justify and say whether consent will be sought.*

The hospital clinical team members will identify potential participants in the course of their usual duties and provide study information in advance of introducing the PI.

For participants recruited from Aston University, the PI will not have any access to any personal information. PIL will be distributed by the PI and upon contacting the PI. The PI will asses for study eligibility.

Storage and use of data after the end of the study

A41. Where will the data generated by the study be analysed and by whom?

The study data will be analysed by the Principal Investigator and the academic supervisory team.

Data will be analysed on Aston University premises.

A42. Who will have control of and act as the custodian for the data generated by the study?

	Title	Forename/Initials	Surname
	Dr	Chi	Huynh
Post	Lecturer in Clinical Pharmacy, Undergraduate Admissions Tutor – MPharm, Programme Director – Masters in Overseas Pharmacy MSc OSPAP		
Qualifications	BSc (Hons), MRPharmS, PhD, PGCert (Learning & Teaching HE), FHEA		
Work Address	Aston University		
	Aston Triangle		
	Birmingham		
Post Code	B4 7ET		
Work Email	c.huynh3@aston.ac.uk		
Work Telephone	0121 204 3231		
Fax			

A43. How long will personal data be stored or accessed after the study has ended?

- ○ Less than 3 months
- ○ 3 – 6 months
- ○ 6 – 12 months
- ○ 12 months – 3 years
- ◉ Over 3 years

If longer than 12 months, please justify:
This project is funded by Aston University. Anonymised research data and hard copies of participant consent forms will be secured archived for six years following the end of the study in accordance with the sponsor's Archiving policy.

A44. For how long will you store research data generated by the study?

Years: 6
Months: 0

A45. Please give details of the long term arrangements for storage of research data after the study has ended. *Say where data will be stored, who will have access and the arrangements to ensure security.*

Upon study completion, study papers including consent and assent forms, anonymised transcribed interview, health literacy assessment papers, observational notes and all study site files will be archived in the Aston University Research Archive.

During the study timeframe, consent and assent forms will be stored in a locked cupboard in a secure office within the study site. Interviews transcripts, health literacy assessment papers and the observational phase notes will be stored in a locked cupboard in a secure office within Aston University pharmacy department only accessible by the PI.

No confidential data will be stored following completion of the study. All research data collected will be anonymised and will be transcribed and coded at the earliest opportunity. Individual data sets will be identified through a pseudonym, e.g. 'Participant 1'.

INCENTIVES AND PAYMENTS

A46. Will research participants receive any payments, reimbursement of expenses or any other benefits or incentives

for taking part in this research?

◉ Yes ○ No

If Yes, please give details. For monetary payments, indicate how much and on what basis this has been determined.
Based on previous research experience, the research team opted to offer participants at the end of each study phase a 10-pound voucher as an appreciation for their efforts and participation.

A47. Will individual researchers receive any personal payment over and above normal salary, or any other benefits or incentives, for taking part in this research?

○ Yes ◉ No

A48. Does the Chief Investigator or any other investigator/collaborator have any direct personal involvement (e.g. financial, share holding, personal relationship etc.) in the organisations sponsoring or funding the research that may give rise to a possible conflict of interest?

○ Yes ◉ No

NOTIFICATION OF OTHER PROFESSIONALS

A49-1. Will you inform the participants' General Practitioners (and/or any other health or care professional responsible for their care) that they are taking part in the study?

○ Yes ◉ No

If Yes, please enclose a copy of the information sheet/letter for the GP/health professional with a version number and date.

PUBLICATION AND DISSEMINATION

A50. Will the research be registered on a public database?

◉ Yes ○ No

Please give details, or justify if not registering the research.
This study is part of the PI`s PhD project, which will be published via Aston University library Website.

Registration of research studies is encouraged wherever possible.
You may be able to register your study through your NHS organisation or a register run by a medical research charity, or publish your protocol through an open access publisher. If you are aware of a suitable register or other method of publication, please give details. If not, you may indicate that no suitable register exists. Please ensure that you have entered registry reference number(s) in question A5-1.

A51. How do you intend to report and disseminate the results of the study? *Tick as appropriate:*

- ☑ Peer reviewed scientific journals
- ☐ Internal report
- ☑ Conference presentation
- ☐ Publication on website
- ☐ Other publication
- ☐ Submission to regulatory authorities
- ☐ Access to raw data and right to publish freely by all investigators in study or by Independent Steering Committee

on behalf of all investigators

☐ No plans to report or disseminate the results

☑ Other (please specify)

-PhD thesis
-Summary report of the findings to the study sites contributors.
-summary report to the participants, for only participants who requested a copy of the results.

A52. If you will be using identifiable personal data, how will you ensure that anonymity will be maintained when publishing the results?

All data will be anonymised as soon as possible following data collection.

Pseudonyms will be used in any published report.

Any quotations from interviews and the observational notes will be anonymised and managed to make sure that the participants who provided the quote cannot be identified by changing/removing identifying information, e.g. rare or unusual disease or treatment.

A53. Will you inform participants of the results?

◉ Yes ○ No

Please give details of how you will inform participants or justify if not doing so.
Participants have been invited to annotate on the consent form their address if they would like a summary of the final report via post.

5. Scientific and Statistical Review

A54. How has the scientific quality of the research been assessed? *Tick as appropriate:*

☐ Independent external review
☐ Review within a company
☐ Review within a multi−centre research group
☑ Review within the Chief Investigator's institution or host organisation
☐ Review within the research team
☑ Review by educational supervisor
☐ Other

Justify and describe the review process and outcome. If the review has been undertaken but not seen by the researcher, give details of the body which has undertaken the review:
The Chief Investigator and co supervisory team have experience of undertaking pharmacy practice research.

The academic supervisory team contributed to the development of the method.

The study protocol has been reviewed by: Joanna Correa West, Medicines Management Nurse and Jeff Aston, Associate Chief Pharmacist working in the NHS, have considered the study protocol and assessed the feasibility/applicability of the proposed methodology in a clinical setting.

For all studies except non-doctoral student research, please enclose a copy of any available scientific critique reports, together with any related correspondence.

For non-doctoral student research, please enclose a copy of the assessment from your educational supervisor/ institution.

A56. How have the statistical aspects of the research been reviewed? *Tick as appropriate:*

☐ Review by independent statistician commissioned by funder or sponsor

☐ Other review by independent statistician

☐ Review by company statistician

☑ Review by a statistician within the Chief Investigator's institution

☐ Review by a statistician within the research team or multi-centre group

☑ Review by educational supervisor

☐ Other review by individual with relevant statistical expertise

☐ No review necessary as only frequencies and associations will be assessed – details of statistical input not required

In all cases please give details below of the individual responsible for reviewing the statistical aspects. If advice has been provided in confidence, give details of the department and institution concerned.

	Title	Forename/Initials	Surname
	Dr	Chi	Huynh
Department	Pharmacy Department		
Institution	Aston University		
Work Address	Aston University		
	Aston Triangle		
	Birmingham		
Post Code	B4 7ET		
Telephone	0121 204 3231		
Fax			
Mobile			
E-mail	c.huynh3@aston.ac.uk		

Please enclose a copy of any available comments or reports from a statistician.

A57. What is the primary outcome measure for the study?

To identify medication administration issues among children aged 0-18 year old in the UK.

A58. What are the secondary outcome measures? *(if any)*

To identify factors associated with medication administration problems among children and young people.

A59. What is the sample size for the research? *How many participants/samples/data records do you plan to study in total? If there is more than one group, please give further details below.*

Total UK sample size:	120
Total international sample size (including UK):	0
Total in European Economic Area:	0

Further details:
For each study phase, the sample size will be as the following:

Up to fifteen parents/informal caregivers of patients in each of the following age groups: 0 to 5 years, 6 to 10 years and 11 to 16 and young people aged 16 to 18 years old will be recruited across the five study sites.

For qualitative research, fifteen participants are generally considered sufficient to establish themes to allow for an in-depth analysis.

A60. How was the sample size decided upon? *If a formal sample size calculation was used, indicate how this was done, giving sufficient information to justify and reproduce the calculation.*

This is a qualitative research project and is designed to explore participants' experiences and challenges. The smaller sample size is appropriate for qualitative research compared to quantitative. A sample size of 15 per age group has been chosen based on previous work, as it has shown that this will provide considered sufficient data and themes to allow an in-depth analysis.

The recruitment of participants for both phases will stop when theoretical saturation is reached. This has been defined as the point at which "no additional data are being found whereby the (researcher) can develop properties of the category".

A61. Will participants be allocated to groups at random?

○ Yes ◉ No

A62. Please describe the methods of analysis (statistical or other appropriate methods, e.g. for qualitative research) by which the data will be evaluated to meet the study objectives.

- Phase one:
The interview transcripts will be analysed using QSR NVivo version 11 programme. All transcripts will be reviewed and initially analysed by the PI to identify related themes within the transcripts. QRS NVivo will support analysing qualitative data, by grouping all related texts and quotes from all transcripts into identified themes; this will further help in determining patterns and associations across the collected data. Finally, results will be presented as themes and supported with anonymised quoted text from the transcripts. IBM SPSS programme will be used to aid in data analysis.

-Phase two:
Parents/ informal caregiver and young people characteristics will be analysed, dose accuracy will be analysed (cut-offs of 20% deviation and > 2 times the dose) and error rates will be compared and linked to tool type, health literacy and the type of dose instructions used. The above data will be gathered and recorded in a Microsoft Excel sheet and IBM SPSS programme will be used to aid in data analysis.

6. MANAGEMENT OF THE RESEARCH

A63. Other key investigators/collaborators. *Please include all grant co-applicants, protocol co-authors and other key members of the Chief Investigator's team, including non-doctoral student researchers.*

	Title	Forename/Initials	Surname
	Ms	Nanna	Christiansen
Post	Associate Chief Pharmacist		
Qualifications	MSc in Pharmacy Practice, MBA		
Employer	Guy's and St Thomas' NHS Foundation Trust		
Work Address	Evelina London Children's Hospital, St Thomas' Hospital Westminster Bridge Road London		
Post Code	SE1 7EH		
Telephone			
Fax			
Mobile			
Work Email	Nanna.Christiansen@gstt.nhs.uk		

	Title	Forename/Initials	Surname
	Ms	Catrin	Barker
Post	Chief Pharmacist at Alder Hey Children's Hospital		
Qualifications	BSc in Pharmacy, MSc in Pharmacology		
Employer	Alder Hey Children's Hospital		
Work Address	Alder Hey Children's NHS Foundation Trust		
	Eaton Road		
	Liverpool		
Post Code	L12 2AP		
Telephone			
Fax			
Mobile			
Work Email	Catrin.Barker@alderhey.nhs.uk		

	Title	Forename/Initials	Surname
	Mr	Steve	Tomlin
Post	Chief Pharmacist		
Qualifications	FFRPS, FRPharmS		
Employer	Great Ormond Street Hospital for Children NHS Foundation Trust		
Work Address	Great Ormond Street Hospital		
	Great Ormond Street		
	London		
Post Code	WC1N 3JH		
Telephone			
Fax			
Mobile	02078298636		
Work Email	Stephen.Tomlin@gosh.nhs.uk		

	Title	Forename/Initials	Surname
	Mr	Jeff	Aston
Post			
Qualifications	BSc in Pharmacy, MSc in Clinical Pharmacy		
Employer	Birmingham Children's Hospital NHS Foundation Trust		
Work Address	Birmingham Children's Hospital		
	Steelhouse Lane		
	Birmingham		
Post Code	B4 6NH		
Telephone			
Fax			
Mobile			
Work Email	jeff.aston@nhs.net		

	Title	Forename/Initials	Surname
	Dr	Chi	Huynh
Post	Lecturer in Clinical Pharmacy		
Qualifications	BSc (Hons), MRPharmS, PhD, PGCert (Learning & Teaching HE), FHEA		
Employer	Aston University		
Work Address	Aston University		
	Aston Triangle		
	Birmingham		

Post Code	B4 7ET
Telephone	
Fax	
Mobile	0121 204 3231
Work Email	c.huynh3@aston.ac.uk

A64. Details of research sponsor(s)

A64-1. Sponsor

Lead Sponsor

Status:
- ○ NHS or HSC care organisation
- ○ Academic
- ○ Pharmaceutical industry
- ○ Medical device industry
- ○ Local Authority
- ○ Other social care provider (including voluntary sector or private organisation)
- ◉ Other

Commercial status: Non-Commercial

If Other, please specify: Aston University

Contact person

Name of organisation	Aston University
Given name	James
Family name	Wolffsohn
Address	Aston University
Town/city	Birmingham
Post code	B4 7ET
Country	UNITED KINGDOM
Telephone	01212044140
Fax	
E-mail	J.S.W.Wolffsohn@aston.ac.uk

A65. Has external funding for the research been secured?

Please tick at least one check box.

- ☐ Funding secured from one or more funders
- ☐ External funding application to one or more funders in progress
- ☑ No application for external funding will be made

What type of research project is this?

- (●) Standalone project
- ( ) Project that is part of a programme grant
- ( ) Project that is part of a Centre grant
- ( ) Project that is part of a fellowship/ personal award/ research training award
- ( ) Other

Other – please state:

A66. Has responsibility for any specific research activities or procedures been delegated to a subcontractor (other than a co-sponsor listed in A64-1) ? *Please give details of subcontractors if applicable.*

( ) Yes (●) No

A67. Has this or a similar application been previously rejected by a Research Ethics Committee in the UK or another country?

( ) Yes (●) No

Please provide a copy of the unfavourable opinion letter(s). You should explain in your answer to question A6-2 how the reasons for the unfavourable opinion have been addressed in this application.

A68-1. Give details of the lead NHS R&D contact for this research:

	Title	Forename/Initials	Surname
	Mrs	Kelly	Hard
Organisation	Birmingham Women's and Children's NHS Foundation Trust		
Address	R&D Office		
	Steelhouse Lane		
	Birmingham		
Post Code	B4 6NH		
Work Email	kellyhard@nhs.net		
Telephone	01213338751		
Fax			
Mobile			

Details can be obtained from the NHS R&D Forum website: http://www.rdforum.nhs.uk

A69-1. How long do you expect the study to last in the UK?

Planned start date: 01/05/2019
Planned end date: 01/05/2020
Total duration:
Years: 1 Months: 0 Days: 1

A71-1. Is this study?

( ) Single centre
(●) Multicentre

A71-2. Where will the research take place? *(Tick as appropriate)*

- [x] England
- [ ] Scotland
- [ ] Wales
- [ ] Northern Ireland
- [ ] Other countries in European Economic Area

Total UK sites in study Up to 5

Does this trial involve countries outside the EU?

○ Yes ◉ No

A72. Which organisations in the UK will host the research? *Please indicate the type of organisation by ticking the box and give approximate numbers if known:*

[x] NHS organisations in England	4
[ ] NHS organisations in Wales	
[ ] NHS organisations in Scotland	
[ ] HSC organisations in Northern Ireland	
[ ] GP practices in England	
[ ] GP practices in Wales	
[ ] GP practices in Scotland	
[ ] GP practices in Northern Ireland	
[ ] Joint health and social care agencies (eg community mental health teams)	
[ ] Local authorities	
[ ] Phase 1 trial units	
[ ] Prison establishments	
[ ] Probation areas	
[ ] Independent (private or voluntary sector) organisations	
[x] Educational establishments	1
[ ] Independent research units	
[ ] Other (give details)	
Total UK sites in study:	5

A73-1. Will potential participants be identified through any organisations other than the research sites listed above?

○ Yes ◉ No

A74. What arrangements are in place for monitoring and auditing the conduct of the research?

The academic supervisor will supervise the progress of the project and conduct of the research.

Aston University (sponsor) will audit the project under its Health Related Research Monitoring and Audit Policy.

A76. Insurance/ indemnity to meet potential legal liabilities

Note: in this question to NHS indemnity schemes include equivalent schemes provided by Health and Social Care (HSC) in Northern Ireland

A76-1. What arrangements will be made for insurance and/or indemnity to meet the potential legal liability of the sponsor(s) for harm to participants arising from the management of the research? *Please tick box(es) as applicable.*

Note: Where a NHS organisation has agreed to act as sponsor or co-sponsor, indemnity is provided through NHS schemes. Indicate if this applies (there is no need to provide documentary evidence). For all other sponsors, please describe the arrangements and provide evidence.

☐ NHS indemnity scheme will apply (NHS sponsors only)

☑ Other insurance or indemnity arrangements will apply (give details below)

Aston University insurance.

Please enclose a copy of relevant documents.

A76-2. What arrangements will be made for insurance and/ or indemnity to meet the potential legal liability of the sponsor(s) or employer(s) for harm to participants arising from the design of the research? *Please tick box(es) as applicable.*

Note: Where researchers with substantive NHS employment contracts have designed the research, indemnity is provided through NHS schemes. Indicate if this applies (there is no need to provide documentary evidence). For other protocol authors (e.g. company employees, university members), please describe the arrangements and provide evidence.

☐ NHS indemnity scheme will apply (protocol authors with NHS contracts only)

☑ Other insurance or indemnity arrangements will apply (give details below)

Aston University insurance.

Please enclose a copy of relevant documents.

A76-3. What arrangements will be made for insurance and/ or indemnity to meet the potential legal liability of investigators/collaborators arising from harm to participants in the conduct of the research?

Note: Where the participants are NHS patients, indemnity is provided through the NHS schemes or through professional indemnity. Indicate if this applies to the whole study (there is no need to provide documentary evidence). Where non-NHS sites are to be included in the research, including private practices, please describe the arrangements which will be made at these sites and provide evidence.

☑ NHS indemnity scheme or professional indemnity will apply (participants recruited at NHS sites only)

☑ Research includes non-NHS sites (give details of insurance/ indemnity arrangements for these sites below)

Aston University insurance.

Please enclose a copy of relevant documents.

A78. Could the research lead to the development of a new product/process or the generation of intellectual property?

○ Yes ○ No ◉ Not sure

PART B: Section 7 - Children

1. Please specify the potential age range of children under 16 who will be included and give reasons for carrying out the research in this age group.

Parents and informal caregivers of children aged 0-16 years old will be the participants in this study. The project is exploring the nature of medication administration challenges and errors among children aged 0 to 18 years old at a home setting where the parents/informal caregivers are involved.

Given the high rates of medication administration errors among children and young people, and due to the limited available information about the types of medication errors in the UK, the research team opted to design this two-phase study to establish the nature of medication administration problem occurring at home and, further, to develop strategies that will help in reducing medication-related errors among children at home.

2. Indicate whether any children under 16 will be recruited as controls and give further details.

No. Not applicable to this research project.

3-2. Please describe the arrangements for seeking informed consent from a person with parental responsibility and/or from children able to give consent for themselves.

For both phases, written consent will be taken from the participant's parent or informal caregivers if the child is under 16 years old, or from the participants if they are aged between 16 to 18 years old.

For phase one, an assent form will be used where the participant is aged 7 years or older and will be signed by the patient alongside the parent/informal caregiver consent form.

4. If you intend to provide children under 16 with information about the research and seek their consent or agreement, please outline how this process will vary according to their age and level of understanding.

For each phase of this study, three age-related Participant Information Leaflets were developed and will be provided to ensure participant engagement at all ages, where possible.

For phase one of this study: An assent form has been developed for use in those children aged 7 years and older where they can understand the project and able to write their name.

Copies of written information sheet(s) for parents and children, consent/assent form(s) and any other explanatory material should be enclosed with the application.

PART C: Overview of research sites

Please enter details of the host organisations (Local Authority, NHS or other) in the UK that will be responsible for the research sites. *For further information please refer to guidance.*

Investigator identifier	Research site		Investigator Name	
IN1	◉ NHS/HSC Site ○ Non-NHS/HSC Site		Forename Middle name Family name Email Qualification (MD...) Country	Nanna Christiansen nanna.christiansen@bartshealth.nhs.uk UNITED KINGDOM
	Organisation name	GUY'S AND ST THOMAS' NHS FOUNDATION TRUST		
	Address	TRUST OFFICES GUY'S HOSPITAL GREAT MAZE POND LONDON GREATER LONDON		
	Post Code	SE1 9RT		
	Country	ENGLAND		
IN2	◉ NHS/HSC Site ○ Non-NHS/HSC Site		Forename Middle name Family name Email Qualification (MD...) Country	Stephen Tomlin Stephen.tomlin@gosh.nhs.uk UNITED KINGDOM
	Organisation name	GREAT ORMOND STREET HOSPITAL FOR CHILDREN NHS FOUNDATION TRUST		
	Address	GREAT ORMOND STREET LONDON GREATER LONDON		
	Post Code	WC1N 3JH		
	Country	ENGLAND		
IN3	◉ NHS/HSC Site ○ Non-NHS/HSC Site		Forename Middle name Family name Email	Jeff Aston jeff.aston@nhs.net

	Organisation name	BIRMINGHAM WOMEN'S AND CHILDREN'S NHS FOUNDATION TRUST	Qualification (MD...)	
	Address	STEELHOUSE LANE	Country	UNITED KINGDOM
		BIRMINGHAM WEST MIDLANDS		
	Post Code	B4 6NH		
	Country	ENGLAND		

IN5	○ NHS/HSC Site ◉ Non-NHS/HSC Site		Forename	Chi
			Middle name	
			Family name	Huynh
			Email	c.huynh3@aston.ac.uk
	Institution name	Aston University	Qualification (MD...)	
	Department name			
	Street address	Aston Triangle	Country	UNITED KINGDOM
	Town/city	Birmingham		
	Post Code	B4 7ET		
	Country	UNITED KINGDOM		

IN7	◉ NHS/HSC Site ○ Non-NHS/HSC Site		Forename	Catrin
			Middle name	
			Family name	Barker
			Email	catrin.barker@alderhey.nhs.uk
	Organisation name	ALDER HEY CHILDREN'S NHS FOUNDATION TRUST	Qualification (MD...)	
	Address	ALDER HEY HOSPITAL	Country	UNITED KINGDOM
		EATON ROAD		
		WEST DERBY LIVERPOOL MERSEYSIDE		
	Post Code	L12 2AP		
	Country	ENGLAND		

PART D: Declarations

D1. Declaration by Chief Investigator

1. The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.
2. I undertake to fulfil the responsibilities of the chief investigator for this study as set out in the UK Policy Framework for Health and Social Care Research.
3. I undertake to abide by the ethical principles underlying the Declaration of Helsinki and good practice guidelines on the proper conduct of research.
4. If the research is approved I undertake to adhere to the study protocol, the terms of the full application as approved and any conditions set out by review bodies in giving approval.
5. I undertake to notify review bodies of substantial amendments to the protocol or the terms of the approved application, and to seek a favourable opinion from the main REC before implementing the amendment.
6. I undertake to submit annual progress reports setting out the progress of the research, as required by review bodies.
7. I am aware of my responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of patient or other personal data, including the need to register when necessary with the appropriate Data Protection Officer. I understand that I am not permitted to disclose identifiable data to third parties unless the disclosure has the consent of the data subject or, in the case of patient data in England and Wales, the disclosure is covered by the terms of an approval under Section 251 of the NHS Act 2006.
8. I understand that research records/data may be subject to inspection by review bodies for audit purposes if required.
9. I understand that any personal data in this application will be held by review bodies and their operational managers and that this will be managed according to the principles established in the Data Protection Act 2018.
10. I understand that the information contained in this application, any supporting documentation and all correspondence with review bodies or their operational managers relating to the application:
    - Will be held by the REC (where applicable) until at least 3 years after the end of the study; and by NHS R&D offices (where the research requires NHS management permission) in accordance with the NHS Code of Practice on Records Management.
    - May be disclosed to the operational managers of review bodies, or the appointing authority for the REC (where applicable), in order to check that the application has been processed correctly or to investigate any complaint.
    - May be seen by auditors appointed to undertake accreditation of RECs (where applicable).
    - Will be subject to the provisions of the Freedom of Information Acts and may be disclosed in response to requests made under the Acts except where statutory exemptions apply.
    - May be sent by email to REC members.
11. I understand that information relating to this research, including the contact details on this application, may be held on national research information systems, and that this will be managed according to the principles established in the Data Protection Act 2018.
12. Where the research is reviewed by a REC within the UK Health Departments Research Ethics Service, I understand that the summary of this study will be published on the website of the Health Research Authority (HRA) together with the contact point for enquiries named below. Publication will take place no earlier than 3 months after the issue of the ethics committee's final opinion or the withdrawal of the application.

Contact point for publication*(Not applicable for R&D Forms)*

HRA would like to include a contact point with the published summary of the study for those wishing to seek further

information. We would be grateful if you would indicate one of the contact points below.

- ◯ Chief Investigator
- ◯ Sponsor
- ◯ Study co-ordinator
- ◯ Student
- ◯ Other – please give details
- ◯ None

Access to application for training purposes *(Not applicable for R&D Forms)*

Optional – please tick as appropriate:

☐ I would be content for members of other RECs to have access to the information in the application in confidence for training purposes. All personal identifiers and references to sponsors, funders and research units would be removed.

This section was signed electronically by Dr Chi Huynh on 02/04/2019 12:54.

Job Title/Post:	Lecturer in Clinical Pharmacy
Organisation:	Aston University
Email:	c.huynh3@aston.ac.uk

D2. Declaration by the sponsor's representative

If there is more than one sponsor, this declaration should be signed on behalf of the co-sponsors by a representative of the lead sponsor named at A64-1.

I confirm that:

1. This research proposal has been discussed with the Chief Investigator and agreement in principle to sponsor the research is in place.
2. An appropriate process of scientific critique has demonstrated that this research proposal is worthwhile and of high scientific quality.
3. Any necessary indemnity or insurance arrangements, as described in question A76, will be in place before this research starts. Insurance or indemnity policies will be renewed for the duration of the study where necessary.
4. Arrangements will be in place before the study starts for the research team to access resources and support to deliver the research as proposed.
5. Arrangements to allocate responsibilities for the management, monitoring and reporting of the research will be in place before the research starts.
6. The responsibilities of sponsors set out in the UK Policy Framework for Health and Social Care Research will be fulfilled in relation to this research.

   Please note: *The declarations below do not form part of the application for approval above. They will not be considered by the Research Ethics Committee.*
7. Where the research is reviewed by a REC within the UK Health Departments Research Ethics Service, I understand that the summary of this study will be published on the website of the National Research Ethics Service (NRES), together with the contact point for enquiries named in this application. Publication will take place no earlier than 3 months after issue of the ethics committee's final opinion or the withdrawal of the application.
8. Specifically, for submissions to the Research Ethics Committees (RECs) I declare that any and all clinical trials approved by the HRA since 30th September 2013 (as defined on IRAS categories as clinical trials of medicines, devices, combination of medicines and devices or other clinical trials) have been registered on a publically accessible register in compliance with the HRA registration requirements for the UK, or that any deferral granted by the HRA still applies.

This section was signed electronically by Wolffsohn James on 02/04/2019 16:20.

Job Title/Post:	Associate PVC Research Integrity
Organisation:	Aston University
Email:	m.richards3@aston.ac.uk

D3. Declaration for student projects by academic supervisor(s)

1. I have read and approved both the research proposal and this application. I am satisfied that the scientific content of the research is satisfactory for an educational qualification at this level.

2. I undertake to fulfil the responsibilities of the supervisor for this study as set out in the UK Policy Framework for Health and Social Care Research.

3. I take responsibility for ensuring that this study is conducted in accordance with the ethical principles underlying the Declaration of Helsinki and good practice guidelines on the proper conduct of research, in conjunction with clinical supervisors as appropriate.

4. I take responsibility for ensuring that the applicant is up to date and complies with the requirements of the law and relevant guidelines relating to security and confidentiality of patient and other personal data, in conjunction with clinical supervisors as appropriate.

Academic supervisor 1

This section was signed electronically by Dr David Terry on 02/04/2019 12:50.

Job Title/Post:	Director - APU
Organisation:	Aston University
Email:	d.terry@aston.ac.uk

Academic supervisor 2

This section was signed electronically by Dr Daniel Kirby on 02/04/2019 13:21.

Job Title/Post:	Lecturer
Organisation:	Aston Pharmacy School
Email:	d.j.kirby1@aston.ac.uk

Academic supervisor 3

This section was signed electronically by Dr Chi Huynh on 02/04/2019 12:55.

Job Title/Post:	Lecturer in Clinical Pharmacy
Organisation:	Aston University
Email:	c.huynh3@aston.ac.uk

Appendix E: Participants Information Sheet for parents and informal caregivers. All yellow highlighted text was localised for each recruiting site.

Site Logo

(to be added)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase-one: Participant Information Leaflet Intended for Parents or Informal Caregivers

Invitation

We would like to invite you and your child to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

IRAS ID: 258491: [Phase one: PIL for Parents/Informal Caregivers], [V0.4], [07/02/2019]

Medication problems frequently occur among children and young people at home, commonly when parents are giving their children their medicine. However, we are looking at the ways that problems which arise when giving medication to children and young people can be prevented or reduced. The aim of the study is ultimately to design a model that can help in minimising children medication-related problems at home. Our study aims to do this by conducting a two-phase study, which will include one-to-one interviews followed by observations.

Today, we are inviting you to take part in phase-one of the study.

Why have I been invited?

You are being invited to take part in this study because:

- You are a parent/informal caregiver (male or female) aged 18 years old or above of a child aged between 0 to16 years old or to a young person aged 16 to 18 years old who is receiving a prescribed medication by the NHS.
- You are responsible or share the responsibility of administrating medication to your child.
- You can speak and read English.

What will happen to me if I take part?

The study involves two stages, but today you are invited to take part in phase-one, which is a face-to-face interview.

If you wish to take part in phase-two, which involves the preparation of sets of liquid medications, please contact the research team (contact details found below).

If you and/or your child decide to take part, the one-to-one interview will be arranged to take place at a convenient time; your child can join in and contribute during the interview if they wish. The

interview will take up to an hour, we will ask you questions about any current or previous issues and challenges you have faced when you give an oral medication to your child, If you would like to see the questions you`ll be asked before deciding, please ask and these will be provided.

The researcher will also assess your health literacy levels, Health Literacy is defined as "The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions". The assessment is only going to take 7 minutes and it will be based on a nutritional information that you usually find on the back of any food products. If you were part of phase-two of this study then you will not do this assessment again.

With your permission we will audio record the interview and take notes. The recording will be typed into a document (transcribed) by the Principal Investigator (Mrs. Dania Dahmash) or by a transcriber approved by Aston University. This process will involve removing any information which could be used to identify individuals e.g. names, locations etc.

Audio recordings will be destroyed as soon as the transcripts have been checked for accuracy. We will ensure that anything you have told us that is included in the reporting of the study will be anonymous. You of course are free not to answer any questions that are asked without giving a reason.

Do I have to take part?

No. It is up to you to decide whether or not you or your child wish to take part.

If you do decide to participate, you will be asked to sign and date a consent form. You would still be free to withdraw from the study at any time without giving a reason.

Will my taking part in this study be kept confidential?

Yes. A code will be attached to all the data you provide to maintain confidentiality.

Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits. Analysis of your data will be undertaken using coded data.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

To ensure the quality of the research Aston University and the NHS Organisation supporting the study may need to access your data to check that the data has been recorded accurately. If this is required your personal data will be treated as confidential by the individuals accessing your data.

What happens if I tell you something that concerns you about my health or welfare or that of the person I care for?

In the unlikely event of this happening, we will discuss with you how this should be addressed. If necessary, to protect you and the person you care for, we will report your concern to the appropriate person or bodies.

What are the possible benefits of taking part?

While there are no direct benefits to you of taking part in this study, the data gained will help us improve our understanding of the types of medication administration errors among children aged 0-18 years old.

What are the possible risks and burdens of taking part?

We cannot promise that taking part will benefit you directly. By taking part, you will help us to understand the types of medication administration issues among children and young people in the UK. Results from this study may be used in the future to help in designing models that can ultimately reduce medication-related-problems among children at home.

IRAS ID: 258491: [Phase one: PIL for Parents/Informal Caregivers], [V0.4], [07/02/2019]

We do not plan to cover any sensitive or embarrassing issues. However, if you feel uncomfortable during the interview, the interviewer will pause for a break, after which you can choose to end the interview or carry on.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential.

A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

The results of the study will also be used in Dania Dahmash PhD thesis.

Expenses and payments

We will offer you a £10 high street shopping voucher in thanks for the time you have taken to take part in this research.

Who is funding the research?

The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.

Who has reviewed the study?

This study was given a favorable ethical opinion by the ***[Name of REC]*** Research Ethics Committee.

Where can I obtain independent advice about participating in clinical research?

If you would like independent advice on any aspect of this study, please contact the PALS (Patient Advice and Liaison Service) at ***[to add the Name of NHS Organisation and contact details-– for the Localised forms – e.g. each hospital will have their own contact details]***.

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Research Team

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

IRAS ID: 258491: [Phase one: PIL for Parents/Informal Caregivers], [V0.4], [07/02/2019]

Thank you for taking time to read this information sheet. If you have any questions regarding the study please don't hesitate to ask one of the research team.

Aston University

Aston University is the sponsor for this study based in the United Kingdom. We will be using information from you, your child and your child's medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after you and your child's information and using it properly. Aston University will keep identifiable information about you and your child for a minimum of 6 years after the study has finished.

You and your child's rights to access, change or move your information are limited, as we need to manage you and your child's information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you and your child that we have already obtained. To safeguard you and your child's rights, we will use the minimum personally identifiable information possible.

You can find out more about how we use your information at www.aston.ac.uk/dataprotection or by contacting our Data Protection Officer at dp_officer@aston.ac.uk.

If you wish to raise a complaint on how we have handled you and/or your child's personal data, you can contact our Data Protection Officer who will investigate the matter. If you are not satisfied with our response or believe we are processing you and/or your child's personal data in a way that is not lawful you can complain to the Information Commissioner's Office (ICO).

[Add NHS site details] will use your and/or your child's name, and contact details to contact you about the research study, and make sure that relevant information about the study is recorded for you and/or your child's care, and to oversee the quality of the study. Individuals from Aston University and regulatory organisations may look at your child's medical records and your and or your child's research records to check the accuracy of the research study. [Add NHS site details] will pass these details to Aston University along with the information collected from you, your child and your child's medical records. The only people in Aston University who will have access to information that identifies you and/or your child will be people who need to contact you to arrange and undertake

research visits or audit the data collection process. The people who analyse the information will not be able to identify you and/or your child and will not be able to find out your names, or contact details.

When you agree to take part in a research study, the information about you and/or your child's health and care may be provided to researchers running other research studies in this organisation and in other organisations. These organisations may be universities, NHS organisations or companies involved in health and care research in this country or abroad. You and/or your child's information will only be used by organisations and researchers to conduct research in accordance with the UK Policy Framework for Health and Social Care Research.

This information will not identify you and will not be combined with other information in a way that could identify you and/or your child. The information will only be used for the purpose of health and care research, and cannot be used to contact you and/or your child or to affect your child's care.

Appendix F: Participants Information Sheet for young people aged between 16 to 18 years old. All yellow highlighted text was localised for each recruiting site.

Site Logo

(to be added)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase one :Participant Information Leaflet intended for Young People Aged 16 to18 Years Old

Invitation

We would like to invite you to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

Medication problems frequently occur among children and young people at home, commonly at a medication administration stage, where a young person is responsible for taking the prescribed oral medication. However, medication problems among children and young people can be prevented or reduced. This project is set up to identify the issues that young people experience when taking their oral medication and untimely design a model that can help in minimising medication-related problems at home among young people. Our study aims to do this by conducting a two-phase study which will include one-to-one interviews followed by observations.

Today, we are inviting you to take part in phase-one of the study.

Why have I been chosen?

You are being invited to take part in this study because:

- You are male or female aged between 16 and 18 years old and receiving a prescribed oral medication from the NHS.
- You are responsible of taking your oral prescribed medication.
- You can speak and read English.

What will happen to me if I take part?

The study involves two stages, but today you are invited to take part in phase-one, which is a face-to-face interview.

If you wish to take part in phase two of the study, which will involve measuring a set of liquids, please contact the research team (contact details found below).

If you decided to take part, the one-to-one interview will be arranged to take place at a convenient time. The interview will take up to an hour, during the course of the interview we will ask you questions about any issues and challenges you have experienced or are still experiencing while taking

your oral medications, if you would like to see the questions you`ll be asked before deciding, please ask and these will be provided.

The researcher will also assess your health literacy levels, Health Literacy is defined as "The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions". The assessment is only going to take 7 minutes and it will be based on a nutritional information that you usually find on the back of any food products. If you were part of phase-two of this study then you will not do this assessment again.

With your permission we will audio record the interview and take notes. The recording will be typed into a document (transcribed) by the Principle Investigator (Mrs. Dania Dahmash) or by a transcriber approved by Aston University. This process will involve removing any information which could be used to identify individuals e.g. names, locations etc.

Audio recordings will be destroyed as soon as the transcripts have been checked for accuracy. We will ensure that anything you have told us that is included in the reporting of the study will be anonymous. You of course are free not to answer any questions that are asked without giving a reason.

Do I have to take part?

No. It is up to you to decide whether or not you wish to take part.

If you do decide to participate, you will be asked to sign and date a consent form. You would still be free to withdraw from the study at any time up without giving a reason.

Will my taking part in this study be kept confidential?

Yes. A code will be attached to all the data you provide to maintain confidentiality.

Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits. Analysis of your data will be undertaken using coded data.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

To ensure the quality of the research Aston University and the NHS Organisation supporting the study may need to access your data to check that the data has been recorded accurately. If this is required your personal data will be treated as confidential by the individuals accessing your data.

What happens if I tell you something that concerns you about my health or welfare or that of the person I care for?

In the unlikely event of this happening, we will discuss with you how this should be addressed. If necessary, to protect you and the person you care for, we will report your concern to the appropriate person or bodies.

What are the possible benefits of taking part?

While there are no direct benefits to you of taking part in this study, the data gained will help us improve our understanding of the types of medication administration errors among children aged 0-18 years old.

What are the possible risks and burdens of taking part?

We cannot promise that taking part will benefit you directly. By taking part, you will help us to understand the types of medication administration issues among children and young people in the UK. The results from this may be used in the future to design models that can help in minimising medication-related-problems among children and young people in the UK.

We do not plan to cover any sensitive or embarrassing issues. However, if you feel uncomfortable during the interview, the interviewer will pause for a break, after which you can choose to end the interview or carry on.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential.

A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

The results of the study will also be used in Dania Dahmash PhD thesis.

Expenses and payments

We will offer you a £10 high street shopping voucher in thanks for the time you have taken to take part in this research.

Who is funding the research?

The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.

Who has reviewed the study?

This study was given a favorable ethical opinion by the ***[Name of REC]*** Research Ethics Committee.

Where can I obtain independent advice about participating in clinical research?

If you would like independent advice on any aspect of this study, please contact the PALS (Patient Advice and Liaison Service) at ***[add Name of NHS Organisation and contact details-– for the Localised forms – e.g. each hospital will have their own contact details].***

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Research Team

- Dr Chi Huynh (Chief investigator)

Email: c.huynh3@aston.ac.uk

Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

Email: dahmashd@aston.ac.uk

Phone: 07392562725

Thank you for taking time to read this information sheet. If you have any questions regarding the study, please do not hesitate to ask one of the research team

Aston University

Aston University is the sponsor for this study based in the United Kingdom. We will be using information from your medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Aston University will keep identifiable information about you for a minimum of 6 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally identifiable information possible.

You can find out more about how we use your information at www.aston.ac.uk/dataprotection or by contacting our Data Protection Officer at dp_officer@aston.ac.uk.

If you wish to raise a complaint on how we have handled your personal data, you can contact our Data Protection Officer who will investigate the matter. If you are not satisfied with our response or believe we are processing your personal data in a way that is not lawful you can complain to the Information Commissioner's Office (ICO).

[ADD NHS TRUST DETAILS] will use your name, and contact details to contact you about the research study, and make sure that relevant information about the study is recorded for your care, and to oversee the quality of the study. Individuals from Aston University and regulatory organisations may look at your medical records and your research records to check the accuracy of the research study. [ADD NHS TRUST DETAILS] will pass these details to Aston University along with the information collected from your medical records. The only people in Aston University who will have access to information that identifies you will be people who need to contact you to arrange and undertake research visits or audit the data collection process. The people who analyse the

information will not be able to identify you and will not be able to find out your name, or contact details.

When you agree to take part in a research study, the information about your health and care may be provided to researchers running other research studies in this organisation and in other organisations. These organisations may be universities, NHS organisations or companies involved in health and care research in this country or abroad. Your information will only be used by organisations and researchers to conduct research in accordance with the UK Policy Framework for Health and Social Care Research.

This information will not identify you and will not be combined with other information in a way that could identify you. The information will only be used for the purpose of health and care research, and cannot be used to contact you or to affect your care.

Appendix I: Participants Information Sheet for children aged between 11 to 15 years old. All yellow highlighted text was localised for each recruiting site.

Site Logo (to be added)

Part one Participant Information Leaflet for Children Aged 11-15 Years Old

Study title "What are the problems that children and parents experience when taking a medication?"

Invitation

We would like to invite you to help us with our research study. Please read this information carefully and talk to your mum, dad or carer about the study. Ask us if there is anything that is not clear or if you want to know more.

Take time to decide whether you want to do this. If you don't then that's fine, you will be looked after at the hospital just the same.

Why we are doing this study?

We want to know what are the mistakes that parents or carers do when giving a medicine to their children by mouth. This study has two parts; today we are inviting you to take part in phase-one, which is an interview. The other part is an observation where we watch while people measure out liquids.

Why have I been asked to take part?

Your parents or carers and you are been invited to take part as you are aged between 11 to 15 years old and you are taking a medicine that your parents or carer gives to you by mouth.

We normally speak to you in hospital before you leave to go home.

Do I have to take part?

No! it is entirely up to you. If you decide to take part:

- We will be asked to sign a form to say that you agree to take part (an assent form: which is an agreement)
- You will be given this information sheet and copy of your signed assent form to keep.

You are free to stop taking part at any point of the study without giving a reason. If you decide to stop, this will not affect the care you receive.

What will happen to me if I take part in the research?

- We would take up to 30 minutes to talk to your parents or carers and ask them question regarding their experience when they give you your medicine. During the talk we will :Ask your parents or caregiver about their current or previous experience regarding giving you your medication and how it affected your health.
- Also, assess your parent or carer health literacy. Health literacy means the ability of a person to understand important health information.

In exchange for participant's time and effort we will be offering all participants a £10 LOVE2SHOP voucher on completion of this study part.

Will joining the study will help me?

No, but the information we will get will might help us know what are the problems that parents/carers experience when they give their child medication by mouth.

What happens when the research study stops?

We will collect all the information together and decide if it is useful in telling us if we can help improve medication administration to children in the future.

Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Contact for information

If you would like any further information about this study you could contact:

- Dr Chi Huynh (Chief investigator)

Email: c.huynh3@aston.ac.uk

Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

Email: dahmashd@aston.ac.uk

Phone: 07392562725

Thank you for reading so far- if you are still interested, please go to part 2:

Part 2-more detail- information you need to know if you still want to take part.

What if I don't want to do the research anymore?

Just tell your mum, dad, carer or the research team at any time. You will still have the same care whilst you are at hospital.

What if there is a problem or something goes wrong?

Tell us if there is a problem and we will try and sort it straight away. Your mum, dad or carer can either contact any of the following:

1- Patient Advice and Liaison services (PALS) at [add Name of NHS Organisation a details].
2- Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Will anyone else know I am doing this?

Only the person who will conduct the interview will know you are taking part.

All information that is collected about you during the research will be kept confidential. You will be given a number, which will be used instead.

What will happen to the results of the research study?

When the study has finished we will be sharing a summary with the participants. The results will be also be included as part of the Principal Investigator educational qualification. They will be anonymous, which means that you will not be able to be identified from them.

Who is funding t

This research is funded by Aston University.

Who has checked the study?

Before any research goes ahead it has to be checked by a Research Ethics Committee. This is a group of people who make sure that the research is OK to do. This study has been looked at by the Black Country Research Ethics Committee

How can I find out more about the research?

If you would like any further information about this study you could contact the research team:

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

Thank you for taking the time to read this-please ask any questions if you need to.

Appendix G: Participants Information Sheet for children aged 6 to 10 years old. All yellow highlighted text was localised for each recruiting site.

Aston University

Site Logo (to be added)

Part one: Participant Information Leaflet for Children Aged 6-10 Years Old

To be shown and read by parent/carer if required

Study title

What are the problems that children and parents experience when taking a medication?

What is research?

Research is a way to help us find out the answer to an important question.

Why we are doing this study?

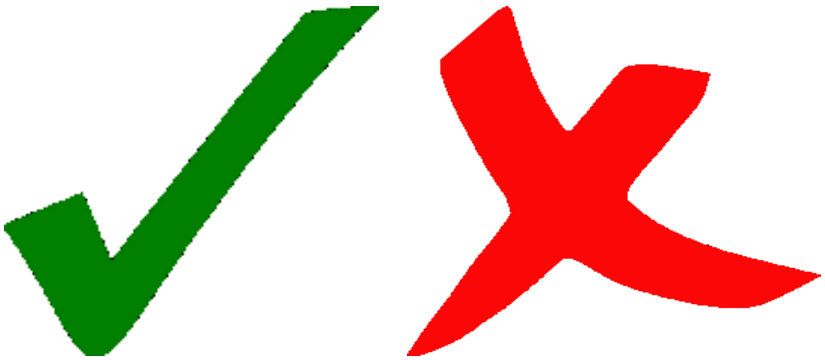
We want to try to find out what are the mistakes that parents or carers do when giving a medicine to you.

Why me?

- You have been chosen because you are a children aged between 6 to 10 years old. Also you are taking a medicine that your parents are giving it to you by mouth. We are asking 60 parents and young people all together.
- We are going to speak to your mum, dad or carer in the hospital and ask them some questions and it won't take longer than half an hour.

Do I have to take part?

No, you do not! It is your choice. We would like you to read this information sheet. If you agree to take part, we would like you to write your name on two forms. We will also ask your mum, dad or carer to write their name on the forms and give one back to us. You can still change your mind later. If you do not want to take part just say no!



What will happen to me if I take part?

Simply we would to ask your parents or carers some questions. We will also ask your parents or carers some food label related questions. The questions will be about what your mum, dad, or carer experience when giving you your medicine. Your mum, dad or carer will be doing something towards the study by answering our questions.

Incase if you refused to be part of the study, your care will be completely the same.

In exchange for your parents or carer time and efforts, we will be offering a 10£ LOVE2SHOP voucher on completion of the study.

What if something goes wrong?

Your mum, dad or carer will be able to talk to someone who will be able to tell them what they need to do about it.

What if I don't want to do the research anymore?

Just tell mum, dad or carer, and the researchers that you don't want to take part anymore. You don't have to give any reason. It is YOUR choice.

What if I want to complain about the study?

If you want to complain you or your mum, dad or carer can talk to **[add Name of NHS Organisation and contact details]** or Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Will anyone else know I`m doing this?

Only the person who spoke to your mum, dad or carer will know you are taking part. No one else will know because we will not use your name. You will get a number which will be used instead.

What happens to what the researchers find out?

Once we finished talking to your parents or carer we will make sure it is stored in a safe place and only the people doing the research can look at it. We will use the information to help other children take their medicine in a better way.

Did anyone else check the study is OK to do?

This study has been checked by several people, to make sure it is alright.

How can I find out more about this study?

Your mum, dad or carer may be able to answer your questions.

Thank you for taking time to read this information sheet- please ask any questions if you need to

.

Appendix H: Participants Information Sheet for children aged 5 years old and younger. All yellow highlighted text was localised for each recruiting site.

Site Logo

(to be added)

Aston University

Phase Two Participant Information Leaflet for Children

Aged Under 5 Years Old

We want to talk to you about a study:

1- Mummy or daddy give you your medicine. Sometimes, though it doesn't go quite right.

2- We want to watch mummy or daddy while they prepare a medicine.

This leaflet is intended for parents/carers to read to the child under 5 years old.

Appendix I: Phase one assent form

Site or Collaborator Logo(s)(to be added- if required)

Aston University

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase One: Assent Form

Name of Chief Investigator: Dr Chi Huynh

This form to be completed by the child (or if unable, parent on their behalf) /young person to circle all they agree with:

1.	Do you confirm that you have or someone has read and explained the study to you?	Yes/No
2.	Do you understand what this project is about?	Yes/No
3.	Do you know that you can stop taking part in the study at any time?	Yes/No
4.	Did you have the opportunity to ask questions about the study?	Yes/No
5.	Have you had your questions answered in a way you understand?	Yes/No
6.	Do you know that the interview will be recorded?	Yes/No
7.	Do you want to take part in the study	Yes/No

If you do not want to take part in the study, do not sign your name.

If you **do** want to take part, you can write your name down below:

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of Person who explained the study	Date	Signature
_____	_____	_____

Appendix J: REMEDY- Phase One Consent form intended to parents and Informal Caregivers

Site or Collaborator Logo(s) (to be added- if required)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase one: Consent Form for Parents and Informal Caregivers

Name of Chief Investigator: Dr Chi Huynh

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet (Version Number and Date) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I understand that if during the study I tell the research team something that causes them to have concerns in relation to my health and/or welfare they may need to breach my confidentiality.	

5.	I agree to my interview being audio recorded and to anonymised direct quotes from me being used in publications resulting from the study.	
6.	I agree to my anonymised data being used by research teams for future research.	
7.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
8.	I agree to take part in this study.	

Provide your address if you wish to receive a summary copy of the results:

_____

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Name of Person receiving consent Date Signature

_____ _____ _____

Appendix K: Consent form for young people aged between 16 to 18 years old.

Site or Collaborator Logo(s) (to be added- if required)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase one: Consent Form for young people aged between 16-18 years old

Name of Chief Investigator: Dr Chi Huynh

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet (Version Number and Date) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I understand that if during the study I tell the research team something that causes them to have concerns in relation to my health and/or welfare they may need to breach my confidentiality.	

5.	I agree to my interview being audio recorded and to anonymised direct quotes from me being used in publications resulting from the study.	
6.	I agree to my anonymised data being used by research teams for future research.	
7.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
8.	I agree to take part in this study.	

Provide your address if you wish to receive a summary copy of the results:

_____

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Name of Person receiving Date Signature

consent

Appendix L: Invitation letter for participant recruitment at Aston University for phase one and phase two

Participants Needed

Study Title: The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

You are invited to participate in a research study ***exploring the types of medication administration problems among children aged 0 to 18 years old***, in the hope of ultimately designing a model that can optimise medication use among children.

This study has two phases:

- Phase one, will involve taking part in a one-to-one interview that will last up to an hour,
- Phase two, will involve preparing a set of liquid medication doses using different measurement tools. *This will be arranged as per participant's convenient time.*

All participants will receive for each phase a ***£10 Love to Shop*** Vouchers for their time.

We are currently recruiting students and staff members to take part in this study, if they are:

1- parents/informal caregivers of a child aged 0 to 18 years who are responsible or share the responsibility of administrating a prescribed oral medication to their child

2- Young people (male of female) aged 16 to 18 years old who are managing their own medications including administration of their prescribed oral medications

IRAS ID: 258491: [REMEY Invitation email for Aston University Staff and Students], [V0.5], [15/05/2019]

3- Speak and understand English

Please contact **Dania Dahmash** for more information, by email

Dahmashd@aston.ac.uk

IRAS ID: 258491: [REMEY Invitation email for Aston University Staff and Students], [V0.5], [15/05/2019]

Appendix M: Interview Guide for parents/informal caregivers and young people.

Interview Guide for Parents/Informal Caregivers

Introduction

Good morning/ afternoon:

I would like to introduce myself, I am Dania Dahmash from Aston University, and I am a research student interested in medication optimisation among children.

I would like to thank you for taking part in this study.

Please feel free to stop me at any time during the interview.

Do you have any question about the study before we start with the interview?

Questions

1. Tell me about the main challenges you ever encountered or still encountering when you give your child his/her medication(s)?
2. Tell me if you have a good or bad experience regarding using a particular medication?
3. When you prepare your child medication, do you usually refer to:
4. the healthcare professional instructions,
5. medication leaflet,
6. your memory recalling instructions from your healthcare professional or,
7. your previous experience?
8. What do you usually do if you did not understand the medication administration instructions?
    a. Call the healthcare professional (Nurse, pharmacist, Dr)
    b. Read the leaflet
    c. Go on line
    d. others (Specify)

IRAS ID: 258491: [REMEY- Phase One Interview Guide for parents and young people], [V0.5], [15/05/2019]

9. Where do you look for information regarding how to administer your child medication?
10. When you prepare your child dose, which measurement tool you reach for?
11. Try to put options… as they could not specify
12. Have you ever experienced any issues regarding measurement tool that has been supplied or provided with the medication?
13. Please let me know if you have any suggestions that you think will help you be more confident when you give your child his/her medication.

Thank you for your inputs.

Interview Guide for Young people aged 16 to18 years old

Introduction

Good morning/ afternoon:

I would like to introduce myself, I am Dania Dahmash from Aston University, and I am a research student interested in medication optimisation among children.

I would like to thank you for taking part in this study.

Please feel free to stop me at any time during the interview.

Do you have any question about the study before we start with the interview?

Questions

1. Tell me about the main challenges you ever encountered or still encountering when you are taking your medication?
2. Tell me if you have a good or bad experience regarding using a particular medication?
3. When you prepare your medication, do you usually refer to
    a. the healthcare professional instructions,
    b. medication leaflet,
    c. your memory recalling instructions from your healthcare professional
    d. or your previous experience?
4. What do you usually do if you did not understand the medication administration instructions?
5. Where do you look for information regarding how to take your medication?
6. Have you ever been prescribed a liquid medication? If **"yes",** ask question **7 and 8** if the answer is **"no" go to question 9.**
7. When you prepare your dose, which measurement tool you reach for? ***(If applicable, ask only if the dosage formulation is liquid).***

IRAS ID: 258491: [REMEY- Phase One Interview Guide for parents and young people], [V0.5], [15/05/2019]

8. Have you ever experience any issues regarding measurement tool that has been supplied or provided with the medication? ***(If applicable, ask only if the dosage formulation is liquid).***
9. Please let me know if you have any suggestions that you think will help you be more confident when you give your child their medication.

Thank you for your inputs.

Appendix N: Newest Vital Sign test to access for partcipants health liearcy levels.

The Newest Vital Sign label

Product Description: Ice Cream

Serving Size: 100ml
Servings per container: 4

NUTRITIONAL INFORMATION	
TYPICAL VALUES	***Per 100ml***
Energy	**1050 kJ**
	250 kcal (calories)
Protein	**4 g**
Carbohydrate	**30 g**
of which sugars	23 g
Fat	**13 g**
of which saturates	9 g
of which monounsaturates	0 g
of which polyunsaturates	3 g
of which trans fats	1 g
Fibre	**0 g**
Sodium	**0.05 g**

Ingredients: Cream, Skimmed Milk, Sugar, Whole Egg, Stabilisers (Guar Gum), Peanut Oil, Vanilla Extract (0.05%).

Newest Vital Sign UK questions including correct responses and Score scheme.

Questions		Answer Correct	
		Yes	No
1	How many calories (kcal) will you eat if you eat the whole container? **Correct response:** 1,000 KCAL or 1,000 CALORIES		
2	If you are advised to eat no more than 60 grams of carbohydrate for dessert, what is the maximum amount of ice cream you could have? **Correct response:** Two servings (or anything up to 2 servings) OR Half the container (or any amount up to half the container) OR 200 ml (or any amount up to 200 ml).		
3	Imagine that your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42 g of saturated fat each day, some of which comes from one serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be eating each day? Correct response: 33 g		
4	If you usually eat 2500 calories each day, what percentage of your daily calorie (kcal) intake will you get if you eat one serving of ice cream? **Correct response:** 1/10 (one tenth) OR 10%		
Imagine that you are allergic to the following substances: penicillin, peanuts, latex gloves, and bee stings.			
5	Is it safe for you to eat this ice cream? Correct response: No		
If 'No' to Q5:			
6	Why not?		

	Correct response: Because it contains peanut oil/peanuts/nuts OR Because you might have an allergic reaction		
ASK IF answer to Q6 is 'Because you might have an allergic reaction':			
7	Why would you have an allergic reaction? **Correct response**: Because it contains peanut oil/peanuts/nuts		
Number of correct answers			

Interpretation

Score of 0-1 suggests high likelihood (50% or more) of limited literacy.

Score of 2-3 indicates the possibility of limited literacy.

Score of 4-6 almost always indicates adequate literacy.

Reference :1- Rowlands G, Khazaezadeh N, Oteng-Ntim E, Seed P, Barr S, Weiss BD. Development and validation of a measure of health literacy in the UK: the newest vital sign. BMC Public Health. 2013;13(1):116.

Appendix O: Phase Two consent form for parents and informal caregivers

Site or Collaborator Logo(s) (to be added- if required)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase Two: Consent Form for Parents and Informal Caregivers

Name of Chief Investigator: Dr Chi Huynh

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet **(Version Number and Date)** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I understand that if during the study I tell the research team something that causes them to have concerns in relation to my health and/or welfare they may need to breach my confidentiality.	
5.	I agree to my anonymised data being used by research teams for future research.	

6.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
7.	I agree to take part in this study.	

Provide your address if you wish to receive a summary copy of the results:

_____

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Name of Person receiving Date Signature consent.

Appendix P: Phase two consent form for young people aged 16 to 18 years old

Site or Collaborator Logo(s) (to be added- if required)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase Two: Consent Form for Young People Aged 16-18 Years Old

Name of Chief Investigator: Dr Chi Huynh

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet **(Version Number and Date)** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I understand that if during the study I tell the research team something that causes them to have concerns in relation to my health and/or welfare they may need to breach my confidentiality.	
5.	I agree to my anonymised data being used by research teams for future research.	

6.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
7.	I agree to take part in this study.	

Provide your address if you wish to receive a summary copy of the results:

_____

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Name of Person receiving Date Signature consen

Appendix Q: Phase two participant Information sheet for parents and informal caregivers. All yellow highlighted text was localised for each recruiting site.

Site Logo (to be added)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase two: Participant Information Leaflet intended for parents/informal caregivers

Invitation

We would like to invite you to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

Medication problems frequently occur among children and young people at home, commonly when parents are giving their children their medicine. However, we are looking at the ways that problems which arise when giving medication to children and young people can be prevented or reduced. The aim of the study is ultimately to design a model that can help in minimising children medication-related problems at home. Our study aims to do this by conducting a two-phase study, which will include one-to-one interviews followed by observations.

Today, we are inviting you to take part in phase two of the study.

Why have I been chosen?

You are being invited to take part in this study because:

- You are a parent/informal caregiver (male or female) aged 18 years old or above of a child aged between 0 to16 years old or to a young person aged 16 to 18 years old who is receiving a prescribed medication by the NHS.
- You are responsible or share the responsibility of administrating medication to your child.
- You can speak and read English.

What will happen to me if I take part?

The study involves two stages, but today you are invited to take part in phase two, which is the demonstrating part of this study.

If you wish to take part in phase one of the study, which will involve a one-to-one interview, please contact the research team (contact details found below).

In this phase, you will be preparing different range of dose volumes using two different liquids one is a suspension (viscous called Cherry Syrup®) and another one is a solution (similar to water in nature called normal saline). The researcher will provide you with a handout. The handout will tell

you how much amount of drug you need to withdraw from the liquids. You will also be provided with different measurement tools to help you prepare the dose. Once you have prepared the dose the researcher will weigh out the tool that contains the medication and record it. During this phase, the researcher will take some notes.

The researcher will also assess your health literacy levels, Health Literacy is defined as "The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions". The assessment is only going to take 7 minutes and it will be based on a nutritional information that you usually find on the back of any food products. If you were part of phase one of this study then you will not do this assessment again.

Do I have to take part?

No. It is up to you to decide whether or not you or your child wish to take part.

If you do decide to participate, you will be asked to sign and date a consent form. You would still be free to withdraw from this phase at any time without giving a reason.

Will my taking part in this study be kept confidential?

Yes. A code will be attached to all the data you provide to maintain confidentiality.

Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits. Analysis of your data will be undertaken using coded data.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

To ensure the quality of the research Aston University and the NHS Organisation supporting the study may need to access your data to check that the data has been recorded accurately. If this is required your personal data will be treated as confidential by the individuals accessing your data.

What are the possible benefits of taking part?

While there are no direct benefits to you of taking part in this study, the data gained will help us improve our understanding of the types of medication administration problems happening at home among children aged 0 to 18 years old in the UK.

What are the possible risks and burdens of taking part?

We cannot promise that taking part will benefit you directly. By taking part, you will help us to understand the types of medication administration issues among children and young people in the UK. The results may be used in the future to design models that can help in reducing medication-related-problems occurring at home.

We do not plan to cover any sensitive or embarrassing issues. However, if you feel uncomfortable during the interview, the interviewer will pause for a break, after which you can choose to end the interview or carry on.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences.

If the results of the study are published, your identity will remain confidential. A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

If the results of the study are published, your identity will remain confidential.

The results of the study will also be used in Dania Dahmash PhD thesis.

Expenses and payments

We will offer you a £10 high street shopping voucher in thanks for the time you have taken to take part in this research.

Who is funding the research?

The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.

Who has reviewed the study?

This study was given a favorable ethical opinion by the ***[Name of REC]*** Research Ethics Committee.

Where can I obtain independent advice about participating in clinical research?

If you would like independent advice on any aspect of this study, please contact the PALS (Patient Advice and Liaison Service) at ***[to add the Name of NHS Organisation and contact details– for the Localised forms – e.g. each hospital will have their own contact details]***.

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Research Team

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

Thank you for taking time to read this information sheet. If you have any questions regarding the study please don't hesitate to ask one of the research team.

Aston University

Aston University is the sponsor for this study based in the United Kingdom. We will be using information from you, your child and your child's medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after you and your child's information and using it properly. Aston University will keep identifiable information about you and your child for a minimum of 6 years after the study has finished.

You and your child's rights to access, change or move your information are limited, as we need to manage you and your child's information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you and your child that we have already obtained. To safeguard you and your child's rights, we will use the minimum personally identifiable information possible.

You can find out more about how we use your information at www.aston.ac.uk/dataprotection or by contacting our Data Protection Officer at dp_officer@aston.ac.uk.

If you wish to raise a complaint on how we have handled you and/or your child's personal data, you can contact our Data Protection Officer who will investigate the matter. If you are not satisfied with our response or believe we are processing you and/or your child's personal data in a way that is not lawful you can complain to the Information Commissioner's Office (ICO).

[Add NHS site details] will use your and/or your child's name, and contact details to contact you about the research study, and make sure that relevant information about the study is recorded for you and/or your child's care, and to oversee the quality of the study. Individuals from Aston University and regulatory organisations may look at your child's medical records and your and or your child's research records to check the accuracy of the research study. [Add NHS site details] will pass these details to Aston University along with the information collected from you, your child and your child's medical records. The only people in Aston University who will have access to information that

identifies you and/or your child will be people who need to contact you to arrange and undertake research visits or audit the data collection process. The people who analyse the information will not be able to identify you and/or your child and will not be able to find out your names, or contact details.

When you agree to take part in a research study, the information about you and/or your child's health and care may be provided to researchers running other research studies in this organisation and in other organisations. These organisations may be universities, NHS organisations or companies involved in health and care research in this country or abroad. You and/or your child's information will only be used by organisations and researchers to conduct research in accordance with the UK Policy Framework for Health and Social Care Research.

This information will not identify you and will not be combined with other information in a way that could identify you and/or your child. The information will only be used for the purpose of health and care research, and cannot be used to contact you and/or your child or to affect your child's care.

Appendix R: Phase two participant Information sheet for young people age 16 to 18 years old. All yellow highlighted text was localised for each recruiting site.

Site Logo (to be added)

The nature of medication administration and dosing issues in children and young people: parental, informal caregiver and young people's experiences - a two-phase study

Phase two: Participant Information Leaflet intended for Young People Aged 16 to 18 Years

Invitation

We would like to invite you to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

Medication problems frequently occur among children and young people at home, commonly at a medication administration stage, where a young person is responsible for taking the prescribed oral

medication. However, medication problems among children and young people can be prevented or reduced. This project is set up to identify the issues that young people experience when taking their oral medication and untimely design a model that can help in minimising medication-related problems at home among young people. Our study aims to do this by conducting a two-phase study which will include one-to-one interviews followed by observations.

Today, we are inviting you to take part in phase two of the study.

Why have I been chosen?

You are being invited to take part in this study because:

- You are male or female aged between 16 and 18 years old and receiving a prescribed oral medication from the NHS..
- You are responsible for taking your oral medication.
- You can speak and read English.

What will happen to me if I take part?

The study involves two stages, but today you are invited to take part in phase two, which is the demonstrating part of this study.

If you wish to take part in phase one of the study please, which involve a one-to-one interview contact the research team (contact details found below).

In this phase, you will be preparing different range of dose volumes using two different liquids; one is a suspension (viscous called Cherry Syrup®) and another one is a solution (similar to water in nature called normal saline). The researcher will provide you with a handout. The handout will tell you how much amount of liquid you need to withdraw from the liquids provided in front of you. You will also be provided with different measurement tools to help you prepare the dose. Once you have

prepared the dose the researcher will weigh out the tool that contains the medication and record it. During this phase the researcher will take some notes.

The researcher will also assess your health literacy levels, Health Literacy is defined as "The individuals' capacity to obtain, process and understand necessary health information and services needed to make appropriate health decisions". The assessment is only going to take 7 minutes and it will be based on a nutritional information that you usually find on the back of any food products. If you were part of phase one of this study then you will not do this assessment again.

Do I have to take part?

No. It is up to you to decide whether or not you wish to take part. If you do decide to participate, you will be asked to sign and date a consent form. You would still be free to withdraw from this phase at any time without giving a reason.

Will my taking part in this study be kept confidential?

Yes. A code will be attached to all the data you provide to maintain confidentiality.

Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits. Analysis of your data will be undertaken using coded data.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device. The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

To ensure the quality of the research Aston University and the NHS Organisation supporting the study may need to access your data to check that the data has been recorded accurately. If this is required your personal data will be treated as confidential by the individuals accessing your data.
IRAS ID: 258491: [Phase Two PIS for Young People], [V0.4], [07/02/2019]

What are the possible benefits of taking part?

While there are no direct benefits to you of taking part in this study, the data gained will help us improve our understanding of the types of medication administration problems happening at home among children aged 0 to 18 years old in the UK.

What are the possible risks and burdens of taking part?

We cannot promise that taking part will benefit you directly. By taking part, you will help us to understand the types of medication administration issues among children and young people in the UK. The results may be used in the future to design models that can help in reducing medication-related-problems occurring at home.

We do not plan to cover any sensitive or embarrassing issues. However, if you feel uncomfortable during the interview, the interviewer will pause for a break, after which you can choose to end the interview or carry on.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences.

If the results of the study are published, your identity will remain confidential. A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

If the results of the study are published, your identity will remain confidential.

The results of the study will also be used in Dania Dahmash PhD thesis.

Expenses and payments

We will offer you a £10 high street shopping voucher in thanks for the time you have taken to take part in this research.

Who is funding the research?

The study is being funded by Aston University .

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.

Who has reviewed the study?

This study was given a favorable ethical opinion by the ***[Name of REC]*** Research Ethics Committee.

Where can I obtain independent advice about participating in clinical research?

If you would like independent advice on any aspect of this study, please contact the PALS (Patient Advice and Liaison Service) at ***[to add the Name of NHS Organisation and contact details-– for the Localised forms – e.g. each hospital will have their own contact details].***

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Research Team

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

Thank you for taking time to read this information sheet. If you have any questions regarding the study, please do not hesitate to ask one of the research team.

Appendix A: Transparency statement

Aston University is the sponsor for this study based in the United Kingdom. We will be using information from your medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Aston University will keep identifiable information about you for a minimum of 6 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally identifiable information possible.

You can find out more about how we use your information at www.aston.ac.uk/dataprotection or by contacting our Data Protection Officer at dp_officer@aston.ac.uk.

If you wish to raise a complaint on how we have handled your personal data, you can contact our Data Protection Officer who will investigate the matter. If you are not satisfied with our response or believe we are processing your personal data in a way that is not lawful you can complain to the Information Commissioner's Office (ICO).

[ADD NHS TRUST DETAILS] will use your name, and contact details to contact you about the research study, and make sure that relevant information about the study is recorded for your care, and to oversee the quality of the study. Individuals from Aston University and regulatory organisations may look at your medical records and your research records to check the accuracy of the research study. [ADD NHS TRUST DETAILS] will pass these details to Aston University along with the information collected from your medical records. The only people in Aston University who will have access to information that identifies you will be people who need to contact you to arrange and undertake research visits or audit the data collection process. The people who analyse the

information will not be able to identify you and will not be able to find out your name, or contact details.

When you agree to take part in a research study, the information about your health and care may be provided to researchers running other research studies in this organisation and in other organisations. These organisations may be universities, NHS organisations or companies involved in health and care research in this country or abroad. Your information will only be used by organisations and researchers to conduct research in accordance with the UK Policy Framework for Health and Social Care Research.

This information will not identify you and will not be combined with other information in a way that could identify you. The information will only be used for the purpose of health and care research, and cannot be used to contact you or to affect your care.

Appendix S: Phase two participant Information sheet for children aged 11 to 15 years old. All yellow highlighted text was localised for each recruiting site.

Site Logo (to be added)

Part two: Participant Information Leaflet for Children

Aged 11-15 Years Old

Study title

What are the problems that children and parents experience when taking a medication?

Invitation

We would like to invite you to help us with our research study. Please read this information carefully and talk to your mum, dad or carer about the study. Ask us if there is anything that is not clear or if you want to know more.

Take time to decide whether you want to do this. If you do not then that is fine, you will be looked after at the hospital just the same.

Why we are doing this study?

IRAS ID: 258491: [Phase Two PIL For Children Aged 11-15], [V0.3], [07/02/2019]

We want to know what are the mistakes that parents or carers do when giving a medicine to their children by mouth. This study has two parts; today we are inviting you to take part in part-two, which is an observation, where we watch, while your parents or caregiver measure out liquids.

Why have I been asked to take part?

Your parents or carers and you are been invited to take part as you are aged between 11 to 15 years old and you are taking a medicine that your parents or carer gives to you by mouth.

Do I have to take part?

No! it is entirely up to you. If you decide to take part, your parents or carers will:

- Be given this information sheet and copy of their signed consent form
- You are free to stop taking part at any point of the study without giving a reason. If you decide to stop, this will not affect the care you receive.

What will happen to me if I take part in the research?

You won't be involved in this part of the research, we will ask your parents or carers to measure out some liquids according to written instructions and the research team will watch and record some notes. Also, we will assess your parent or carer health literacy

In exchange for participants time and effort we will be offering all participants a £10 LOVE2 voucher on completion of this study part.

Health literacy means the ability of a person to understand important health information.

Will joining the study will help me?

No, but the information we will get will might help us know what are the problems that parents/carers experience when they give their child medication by mouth.

What happens when the research study stops?

We will collect all the information together and decide if it is useful in telling us if we can help improve medication administration to children in the future.

Contact for further information

If you would like any further information about this study, you could contact:

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

IRAS ID: 258491: [Phase Two PIL For Children Aged 11-15], [V0.3], [07/02/2019]

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

Thank you for reading so far- if you are still interested, please go to part 2:

What if I don't want to do the research anymore?

Just tell your mum, dad, carer or the research team at any time. You will still have the same care whilst you are at hospital.

What if there is a problem or something goes wrong?

Tell us if there is a problem and we will try and sort it straight away. Your mum, dad or carer can either contact any of the following:

1- Patient Advice and Liaison services (PALS) at [add Name of NHS Organisation and contact details].
2- Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Will anyone else know I am doing this?

Only the person who will conduct the observational session will know you are taking part.

All information that is collected about you during the research will be kept confidential. You will be given a number, which will be used instead.

What will happen to the results of the research study?

When the study has finished we will be sharing a summary with the participants. The results will be also be included as part of the Principal Investigator educational qualification. They will be anonymous, which means that you will not be able to be identified from them.

Who is funding the research?

This research is funded by Aston University.

Who has checked the study?

Before any research goes ahead it has to be checked by a Research Ethics Committee. This is a group of people who make sure that the research is OK to do. This study has been looked at by the Black Country Research Ethics Committee.

How can I find out more about the research?

If you would like any further information about this study, you could contact the research team:

IRAS ID: 258491: [Phase Two PIL For Children Aged 11-15], [V0.3], [07/02/2019]

- Dr Chi Huynh (Chief investigator)

  Email: c.huynh3@aston.ac.uk

  Phone: 0121 204 3231

- Mrs Dania Dahmash (Principal Investigator)

  Email: dahmashd@aston.ac.uk

  Phone: 07392562725

Thank you for taking the time to read this-please ask any questions if you need t

Appendix T: Phase two participant Information sheet for children aged 6 to 10 years old. All yellow highlighted text was localised for each recruiting site.

Aston University

Part two: Participant Information Leaflet for Children Aged 6-10 Years Old

Study title

What are the problems that children and parents experience when taking a medication?

What is research?

Research is a way to help us find out the answer to an important question.

Why we are doing this study?

We want to try to find out what are the problems that parents or carers experience when they are measuring out a medicine.

Why me?

- You have been chosen because you are a children aged between 6 to 10 years old. Also you are taking a medicine that your parents are giving it to you by mouth. We are asking 60 parents and young people all together.

- We are going to ask your mum, dad or carer to major a liquid to see how they are doing it, we will take some notes and ask them some questions and it won't take longer than half an hour.

Do I have to take part?

No, you do not! It is your choice. We would like you to read this information sheet. If you agree to take part, we would like you to write your name on two forms. We will also ask your mum, dad or carer to write their name on the forms and give one back to us. You can still change your mind later. If you do not want to take part just say no!

What will happen to me if I take part?

Simply we would to ask your parents or carers to measure some clear liquids. We will also ask your parents or carers some food label related questions. Your mum, dad or carer will be doing something towards the study by answering our questions.

Incase if you refused to be part of the study, your care will be completely the same.

In exchange for your parents or carer time and efforts, we will be offering a 10£ LOVE2SHOP voucher on completion of the study.

What if something goes wrong?

Your mum, dad or carer will be able to talk to someone who will be able to tell them what they need to do about it.

What if I don't want to do the research anymore?

Just tell mum, dad or carer, and the researchers that you don't want to take part anymore. You don't have to give any reason. It is YOUR choice.

What if I want to complain about the study?

If you want to complain you or your mum, dad or carer can talk to **[add Name of NHS Organisation and contact details]** or Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Will anyone else know I`m doing this?

Only the person who spoke to your mum, dad or carer will know you are taking part. No one else will know because we will not use your name. You will get a number which will be used instead.

What happens to what the researchers find out?

Once we finished talking to your parents or carer we will make sure it is stored in a safe place and only the people doing the research can look at it. We will use the information to help other children take their medicine in a better way.

Did anyone else check the study is OK to do?

This study has been checked by several people, to make sure it is alright.

How can I find out more about this study?

Your mum, dad or carer may be able to answer your questions.

Thank you for taking time to read this information sheet- please ask any questions if you need to.

Appendix U: Phase two participant Information sheet for children under the age of 5.

All yellow highlighted text was localised for each recruiting site.

Aston University

Site Logo (to be added)

Phase Two Participant Information Leaflet for Children

Aged Under 5 Years Old

We want to talk to you about a study:

1- Mummy or daddy give you your medicine. Sometimes, though it doesn't go quite right.

2- We want to watch mummy or daddy while they prepare a medicine.

This leaflet is intended for parents/carers to read to the child under 5 years old.
IRAS ID: 258491: [Phase one: PIL for Children under the age of 5], [V0.4], [07/02/2019]

Appendix V: Phase two observational guide to the participant

Phase Two: Participant guide

This handout will be provided to the consented participants to ensure consistency of the observational phase across all participants.

Good morning/ afternoon,

Thank you for taking part in our study today.

The researcher will explain to you the study and what you have to do.

You can stop at any time if wish and withdraw from the study.

1- In front of you there is the following measurement tools:
    a- Cups
    b- Spoons
    c- Syringes
2- In front of you there are two bottles labelled as ; bottle (A) and bottle (B).

Please prepare the following doses

A- From Bottle A: measure the following volumes

Number	Instructions
A.1.	0.55 ml
A.2.	0.75 ml
A.3.	1.60 ml
A.4.	4.5 ml
A.5.	5.8 ml
A.6.	7.5 ml

IRAS ID: 258491: [Phase Two PI guide], [V0.2], [24/01/2019]

A.7.	10.5 ml

B- From Bottle B: measure the following volumes

Number	Instruction
B.1.	0.55 ml
B.2.	0.75 ml
B.3.	1.60 ml
B.4.	4.5 ml
B.5.	5.8 ml
B.6.	7.5 ml
B.7.	10.5 ml

Appendix W: Phase Two: Principle Investigator observational note template

The following document will present the observational note template that will be issued for each participant; this will help the PI record any observational activities during this non-interventional phase.

Participant reference number:

Date:

Age:

1- In front of you there is the following measurement tools:

Measurement tool	Observational notes by the PI
Cups	
Spoons	
Syringes	

2- In front of you there are two bottles labelled as ; bottle (A) and bottle (B).

Please prepare the following doses

C- From Bottle A: measure the following volumes

Number	Instructions	Observational notes and weight recording by PI
A.1.	0.55 ml	
A.2.	0.75 ml	
A.3.	1.60 ml	

A.4.	4.5 ml	
A.5.	5.8 ml	
A.6.	7.5 ml	
A.7.	10.5 ml	

D- From Bottle B: measure the following volumes

Number	Instruction	Observational notes and weight recording by PI
B.1.	0.55 ml	
B.2.	0.75 ml	
B.3.	1.60 ml	
B.4.	4.5 ml	
B.5.	5.8 ml	
B.6.	7.5 ml	
B.7.	10.5 ml	