

Problems with oral formulations prescribed to children: a focus group study of healthcare professionals

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Abstract *Background* There is evidence to suggest that adherence with prescribed medication is lower amongst adolescents and children than in adults. Medication adherence rates between 11 and 93 % in paediatric patients have been reported. More research needs to be carried out in order to understand why medicines adherence is low and how adherence can be improved in children with long-term conditions. Personal communication with paediatricians in secondary care has highlighted that problems are most likely to be encountered by parents, carers, nurses and children themselves when administering medicines for prevalent long-term childhood conditions. *Objective* To explore problems with oral medicines prescribed to paediatric patients from the perspectives of medical practitioners, pharmacists and nurses. *Setting* Two NHS trusts in the West Midlands, UK. *Methods* Four focus groups (FG) were conducted. Five nurses, eight medical practitioners and six pharmacists participated in focus

groups. The themes explored were problems experienced when prescribing, dispensing and administering oral medicines for children. *Main outcome measure* Themes evolving from Healthcare professionals reports on problems with administering medicines to paediatric patients. *Results* Two main themes: sensory and non-sensory emerged from the data. Included within these were taste, texture, colour, smell, size, swallowing, quantity, volume and manipulation with food. Taste was the most commonly reported barrier to medicines administration. Texture was reported to be a significant problem for the learning disability population. Medicines manipulation techniques were revealed across the groups, yet there was limited knowledge regarding the evidence base for such activity. Problems surrounding the supply of Specials medicines were discussed in-depth by the pharmacists. *Conclusion* Organoleptic and physical properties of medicines are key barriers to medicines administration. A robust scientific evidence-based approach is warranted to inform standardised protocols guiding healthcare professionals to support safe and effective medicines manipulation across all settings. Pharmacists' knowledge of Specials medicines needs to be recognised as a valuable resource for doctors. Findings of this study should help to optimise paediatric prescribing and direct future formulation work.

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Impacts on practice

- A large number of issues are perceived by healthcare professionals to cause problems when administering oral medicines to children. Taste was highlighted as the most significant issue.

- Nurses had the greatest knowledge of bedside issues, whilst pharmacists understood the consequences of certain manipulations; wider sharing of this knowledge can help to ensure appropriate medicines are prescribed to minimise issues with administration.
- The scientific evidence base for medicines manipulation requires further development; it is evident that medical practitioners require more information when prescribing medicines to ensure supply, clinical effectiveness and to maximise cost efficiency.
- Addressing the education of healthcare professionals involved in prescribing, dispensing and administering oral medicines to children will be invaluable to improving the therapeutic treatment of paediatric patients.

Introduction

There is evidence to suggest that adherence with prescribed medication is lower amongst adolescents and children (0–17 years) than in adults [1]. Medication adherence rates between 11 and 93 % in paediatric patients have been reported [2]. A median rate of 58 % medicine adherence in youth has been estimated [3]. As one in five children in the UK has a long standing illness or disability [4] it is critical that more research needs to be carried out in order to understand why medicines adherence is low and how adherence can be improved in children with long-term conditions. Personal communication with paediatricians in secondary care has highlighted that problems are most likely to be encountered by parents, carers, nurses and children themselves when having to administer medication for prevalent long-term childhood conditions, notably: diabetes, Human immunodeficiency virus (HIV), asthma, Tuberculosis (TB), rheumatic diseases amongst others. It is predicted that issues experienced with medicines will be influenced by the child's age and disease state.

Problems with children's medicines may be influenced by many factors. These include issues with prescribing and the supply of medicines, the prevalence of unlicensed medicines and medicines prescribed off-label [5, 6], difficulties with administering medicines (including manipulation of medicines [7, 8]), behaviour around medicine taking (including influence of family, school and life situation) [9], adverse effects of medicines and medicine adherence problems in specific patient groups (i.e. age groups and chronic conditions). Particularly, research on juvenile diabetes, haemophilia and rheumatoid arthritis has revealed the potential vulnerability of young people to medication non-adherence [10].

Anecdotal parental reports suggest that healthcare professionals may not be aware of the specific barriers and

problems that patients and their parents and carers perceive and experience daily when administering medicines to children. Medicines may be manipulated by parents, carers and young people for which there is often a lack of robust scientific evidence. Parents, carers and young people may decide to manipulate medicines of their own accord, unbeknown to the responsible medical practitioner. Alternatively medicines manipulation may be performed following a recommendation from a healthcare professional.

There is a paucity of research investigating healthcare professionals' perceptions of issues with medicines used to treat paediatric patients with chronic conditions. Studies that have been conducted include an exploration of healthcare providers' views on HIV adherence in paediatric patients [11], an investigation into nurses' knowledge and practice of mixing medicines with foodstuffs [12] and those investigating unlicensed medicines use [13, 14]. The present study aimed to have a more diverse approach, exploring the perspectives of allied healthcare professionals (medical practitioners, nurses and pharmacists) with regard to problems with oral medicines prescribed to children.

Aim of the study

The objective of the focus groups was to explore and understand the problems experienced when prescribing, dispensing and administering oral medicines to children from the perspectives of medical practitioners, pharmacists and nurses. The aim of this was to identify common and unique themes across healthcare professional groups regarding problems with oral medicines prescribed to paediatric patients and furthermore to compare their views with those of parents, carers and children in the second part of the larger FIND OUT study (REC no: 10/H1207/47).

Ethical approval

Ethical approval was granted by the South Birmingham REC, UK (REC no: 10/H1207/47).

Methods

Initial ideas generated by RV with the advice of the Professor of Clinical Pharmacy (JM) and a Consultant Paediatrician (HS) were informed by healthcare professionals in pre-study hospital visits and by study objectives. The different professional backgrounds of the individuals involved in study design permitted the collaboration of a clinical and pharmaceutical input. Ideas were used to develop a template plan of key topics for exploration in the focus groups. The

same key topics surrounding problems with oral medicines in children were highlighted in each focus group to provoke participant interaction and discussion in the groups.

Children suffering from chronic conditions often have regular appointments in the secondary care setting to review their condition and medicines. In the hospital environment, different members of the healthcare team are responsible for providing care for patients. This multidisciplinary healthcare team includes medical practitioners, nurses and pharmacists of varying expertise and with different specialist interests.

This study was conducted with healthcare professionals at University Hospitals Coventry and Warwickshire (UHCW) and Birmingham Children's Hospital (BCH), UK. Healthcare professionals were invited to join a focus group by posters mounted on walls at UHCW and also contacted via the UHCW email system and invited to respond to register an interest to participate. In addition, targeted emails were sent to paediatric pharmacists in the West Midlands region. An information sheet designed using guidance from the National Patient Safety Agency (NPSA) [15] was distributed with the invitation email. General Practitioners (GPs) in Coventry and Warwickshire were informed of the study via a study summary article in the clinical pharmacology e-newsletter, routinely disseminated to all GPs in Coventry and Warwickshire.

Four uniprofessional focus groups were conducted involving nurses, medical practitioners, pharmacists at UHCW, and a further group of pharmacists at BCH. The four focus groups were conducted between September 2010 and February 2011. The second pharmacist focus group was arranged for pharmacists at BCH. These pharmacists had generated interest in the study but were unable to attend the UHCW session for logistical reasons. The introduction for each focus group followed the same structure and included obtaining written consent from each participant to permit publication of anonymised quotations, followed by a reminder about confidentiality issues. The planning and conducting stages of the focus group sessions were carried out according to defined procedures [16]. Focus group design was informed by anecdotal information from parents, children and healthcare professionals. The four focus groups were facilitated by RV and assisted by JM/HS. The groups were digitally audio-recorded and complementary notes were taken during the sessions.

RV transcribed each focus group. Complementary notes recorded during the sessions were used to optimise accuracy of the verbatim transcripts. The focus groups data was analysed using a framework analysis approach, following published guidance [17]. The template plan of topics was used to explore and identify the themes revealed in each transcript. Following this, common themes revealed across the groups and those unique to each group were identified. The thematic analysis program QSR NVivo supported this analysis.

Results

Four focus groups were conducted with the following healthcare professionals:

1. Nurses [n = 5: Neonatal nurse practitioners (n = 2), a nurse with a specialist interest in CF, a community-based nurse and a nurse practice educator],
2. Medical practitioners [n = 8: Paediatric consultants with specialist interests (n = 6), a paediatric specialist registrar, and a GP with an interest in paediatrics].
3. Paediatric pharmacists (n = 2).
4. Paediatric pharmacists (n = 4).

Focus groups 1–3 were conducted at UHCW. Focus group 4 was conducted at BCH. The nurse and medical practitioner groups were conducted at lunchtime and the pharmacist groups took place in allocated study time. Groups lasted between 51 and 93 min.

Following the framework analysis, a structured thematic coding spine (see Table 1) was created based on two main themes: sensory and non-sensory (social and situational). Ten sub-themes emerged from the focus groups. The coding spine includes themes revealed both independently and across the focus groups. The results of the analysis are discussed systematically, using the thematic headings and sub-headings listed in Table 1.

Sensory themes

Oral formulation-related barriers to medicines administration

Commonly reported oral formulation-related barriers to the acceptance of medicines in children across the four focus groups included taste, texture, size of solid dosage form, and volume. Taste was the most prevalent oral formulation-related problem highlighted across the groups. Flucloxacillin solution was perceived by all healthcare professional groups to be disliked by children due to its taste.

Chloral hydrate solution, prednisolone soluble tablets and Movicol[®] (macrogol '3350') oral powder were all highlighted with respect to taste in two of the focus groups.

Taste issues with specific formulations revealed in the focus groups in Table 1.

All medicines reported with taste problems in the focus groups were perceived by participants to cause problems with adherence.

All of the healthcare professional groups highlighted that children experience problems with the textures of some medicines. The learning disability population were discussed as a problematic patient population across the focus groups when regarding problems with texture. All groups acknowledged that children taking antiretroviral tablets

Table 1 Thematic coding spine detailing thematic headings and thematic sub-headings

Thematic headings	Thematic sub-headings 1	Thematic sub-headings 2
<i>Sensory themes</i>		
Oral formulation-related barriers to medicines administration	Taste-related problems	
	^a <i>Gastrografin</i> [®] (<i>sodium diatrizoate/meglumine diatrizoate</i>) solution—Nurse 4. <i>Oramorph</i> [®] (<i>morphine sulfate</i>) solution—Nurse 1. <i>Seprin</i> [®] (<i>trimethoprim and sulfamethoxazole</i>) paediatric suspension—Pharmacist 2 UHCW. <i>Rifampicin suspension</i> —Pharmacist 1 UHCW. <i>Kaletra</i> [®] (<i>lopinavir/ritonavir</i>) solution—MP 7 describes burning sensation. <i>Nitrofurantoin Special suspension</i> —MP 5. <i>Clarithromycin suspension</i> —MP 2. <i>Generic paracetamol suspension</i> —Nurse 2	
	Problems with texture	
	^a <i>Ciclosporin solution</i> (pharmacist 1 UHCW described as oily). <i>Lactulose solution</i> (MP 1 described as oily). <i>Topiramate sprinkle capsules</i> (MP 1). <i>Calcichew</i> [®] (<i>calcium carbonate</i>) tablets (MP 2). <i>Creon</i> [®] (<i>pancreatin</i>) <i>Micro gastro-resistant granules</i> —inconvenience of transporting apple puree to mask texture (nurse 4)	
	Problems with colour and smell	
	^a <i>Rifampicin liquid</i> —red colour described as “off-putting” (nurse 1). <i>Klean-prep</i> [®] (<i>macrogol ‘3350’</i>) liquid—“smell makes you wretch, it’s horrible” (nurse 4). <i>Abidec</i> [®] <i>vitamin drops</i> —bad smell and the colour stains bibs, yet tolerated (nurse 4). ‘ <i>Horrendous feeds</i> ’ and a smell that “pervades everything” (nurse 1)	
Future medicines for children	Problems with size and swallowing	
	^a <i>Ethambutol tablets</i> (pharmacist 2 described that often multiple small tablets are preferred). <i>Slow sodium</i> [®] (<i>sodium chloride</i>) tablets—“Like an old paracetamol tablet, they’re quite sticky to swallow down” (nurse 4). <i>Temozolomide tablets</i> —“I think they’re quite big drugs” (nurse 6). <i>Antiretroviral tablets</i> (all groups)	
	Problems with quantity and volume	
	^a <i>Chloral hydrate solution</i> ^b described as having a “huge volume” (nurse 1 and pharmacist 1 UHCW). <i>Movicol</i> [®] (<i>macrogol ‘3350’</i>) <i>oral powder</i> ^c (Pharmacists agree large volume). <i>Soluble prednisolone tablets</i> (nurse 3). <i>Antiretroviral liquids</i> —“liquid volumes are so high” (MP 7). Administering <i>considerable volumes of medicines in addition to feeds</i> in neonates, voiced by nurse 3	
Problems related to medicines administration	Ideal improvements to medicines	
	Well-accepted medicines	
	Administration problems with specific medicines Interactions with foodstuffs and sub-optimal drug absorption Medicines manipulation	(The knowledge of healthcare professionals regarding physicochemical effects of medicines manipulation, Evidence base for medicines manipulation)
<i>Non-sensory themes</i>		
Frequent issues experienced when treating paediatric patients	Specials medicines, unlicensed medicines and off-label administration	
	Omeprazole formulations	(Omeprazole liquid, Losec [®] MUPS- licensed omeprazole formulation)

Table 1 continued

Thematic headings	Thematic sub-headings 1	Thematic sub-headings 2
	The knowledge and understanding of medical practitioners, pharmacists and parents regarding unlicensed medicine	
	Extemporaneous dispensing	
Parental understanding of medicines	Educating parents and children about medicines	
	Social problems and language barriers	
Medicines adherence	The relationship between age of child and dosage form preference	
	Parental influence on dosage form choice and medicines adherence	
	The relationship between age of child, disease status, diagnosis, miscellaneous variants and medicines adherence	
	Polypharmacy	
Adverse effects of medicines	Excipients	
	Adverse effects associated with specific medicines	
The supply of medicines and liquid measuring devices	Problems with the supply of oral syringes and the accuracy of measuring liquid medicines	
Medication errors in pharmacies and GP practices	Standardising the labelling of liquid medicines	
	Medicine selection errors at GP practices	
Problems with medicines at school	Problems with medicines at school	

^a Problems with specific medicines or groups of medicines, as reported by the healthcare professionals indicated

^b Choral hydrate—dose for 1–12 year olds approximately 5–20 ml ‘well diluted with water’ [18]

^c Movicol[®] (macrogol ‘3350’) oral powder—each sachet added to 125 ml of water [18]

experience problems with their size and also difficulties when swallowing them. In particular, Kaletra[®] (lopinavir/ritonavir) tablets were mentioned to be problematic. Additionally, large dose volumes were perceived to be a barrier to medicines administration and examples of formulations with large dose volumes were volunteered across the groups.

The nurses reported the widest variety of oral formulation-related barriers to medicines administration including those that affect sensory perceptions (colour and smell).

Future medicines for children

The nurses and medical practitioners prioritised the improvement of a variety of poorly palatable medicines. However, the pharmacists perceived that an improvement to Specials medicines would be ideal. In the UK, Healthcare professionals may consider it necessary to prescribe or advise the use of an unlicensed medicine when no licensed, suitable alternative is available, and in which case the medicine may be ordered from a Specials manufacturer (Specials medicine). Medicines legislation (specifically, The Medicines for Human Use Marketing Authorisations Etc Regulations 1994/SI 3144) states that medicinal products

require a licence before they are marketed in the UK [19]. Pharmacists felt that providing Certificates of Analyses to assure the safety and stability of Specials medicines and also licensing some medicines not commercially available in child appropriate formulations should be considered in order to improve medicines for children. Improving Specials medicines was not reported as an ideal medicine improvement by the nurses or medical practitioners, suggesting that this problem is not such a concern for them. Calpol[®] (paracetamol) suspension was presented as a favourite, well-liked medicine formulation in all of the groups.

Problems related to medicines administration

All groups discussed ad hoc manipulation techniques that had been reported to them by parents and carers and also those that they recommend to parents and carers to facilitate the administration of medicines to children (see Fig. 1).

Manipulation techniques were discussed in detail by the nurses. The nurses provided examples of medicines manipulation on wards and also highlighted how parents administer medicines at home. Pharmacists showed most

Medical Practitioners	Nurses	Pharmacists
<ul style="list-style-type: none"> • Epilim® (sodium valproate) granules on jam on toast • Mix in blackcurrant/ orange juice/milk, crush it in to jam or yoghurt • Give a sweet after flucloxacillin • Prednisolone soluble tablets mixed with neat ribena • Methotrexate and mercaptopurine tablets “I’m sure they must get crushed up those” • Melatonin “I’ll always say yoghurt, the advice I would normally give, put it in yoghurt and do that immediately before you go to bed because it denatures before... and don’t use it in hot food” 	<ul style="list-style-type: none"> • Yoghurt with crushed medicines • Use strong flavours to mask-gastrografin® (sodium diatrizoate/meglumine diatrizoate); coke or ribena • Soluble prednisolone in minimal water • Creon ® (pancreatin) Micro gastro-resistant granules in apple puree to mask texture • “The Movicol ® (macrogol '3350') rep says you can put it into jellies and things” • In reference to Movicol® (macrogol '3350'): “People hide it in their dinners.. their mash potato..” • Warm water to dissolve Losec® (omeprazole) MUPS • ‘Not x goes with y, just try whatever the child likes’ 	<ul style="list-style-type: none"> • Creon® (pancreatin) Micro gastro-resistant granules with a spoonful of breast milk, apple puree or baby rice • “Ciclosporin you can mix with stuff” • Grinding tablets and mixing with yoghurt or dissolving in water (mercaptopurine) • Liquid paraffin and ice-cream recommended as a technique to numb taste buds • “Stick in a bit of yogh- put it in a bit of banana or something like that you can slip things down if you’ve got something that’s a bit harder to take” • ‘Get down them in any way’ • Losec® (omeprazole) MUPS with squash and juice • Topamax® (topiramate) sprinkle on foodstuffs • Before dispersible tablets were available, recommended opening capsules of melatonin or dispersing them in yoghurt • Movicol® (macrogol '3350') oral powder advice.. “in apple puree and stuff.” <p>Mixing advice is provided in drug information sheets, but is not referenced</p>

Fig. 1 Examples of ad hoc administration techniques reported by the indicated healthcare professional groups

concern regarding pharmacokinetic effects. An example of this was their unanimous appreciation of mixing medicines with food-stuffs (i.e. orange juice), and the potential effects of altering pH on the drug. The nurse group also highlighted risks of altering drug stability when mixing medicines with substrates prior to administration. The medical practitioners reported more information on what parents actually do to the medicines.

Non-sensory themes

Frequent issues experienced when treating paediatric patients, the supply of medicines and liquid measuring devices

...the things I dread are when we have all these weird and wonderful specials (Pharmacist 1 UHCW)

The problems with Specials and unlicensed medicines were discussed in all groups and extensively amongst the pharmacists. Issues with omeprazole liquid Special were identified across the groups, these included problems regarding: obtaining, costing (between £100 and £120), GP prescribing [with reference to Primary Care Trust (PCT) guidance described first-hand by the GP in the medical practitioners group, in relation to budget], storage and short expiries. An alternative omeprazole formulation is Losec® MUPS (omeprazole) tablets. Problems with Losec® MUPS (omeprazole) blocking feeding tubes were highlighted in all groups.

Problems with Specials medicines were a main focus of the pharmacist groups. Pharmacists demonstrated their increased

knowledge, awareness and enthusiasm regarding Specials medicines. They discussed a variety of problems surrounding Specials which they frequently experienced first-hand (e.g. unpredictable bioequivalence between different Specials medicines) compared to the medical practitioners and nurses. The medical practitioners seemed to have the least understanding and knowledge of the depth of issues with Specials and tended to identify Specials medicines and issues with supply. The medical practitioner group suggested that some pharmacists may not be aware that certain medicines can be ordered and query whether pharmacists remind patients about the shortened expiries of Specials medicines and the need to frequently re-order. The nurses expressed their concern towards extemporaneously dispensed products and the inconvenience of frequent journeys to hospital pharmacy.

Parental understanding of medicines

Parental influence on medicines adherence and also limited parental understanding of medicines was reported across all healthcare professional groups. The nurses emphasised the need for parental education, whilst the BCH pharmacist group acknowledged the limited time available to counsel patients effectively, resulting in their reliance upon nursing staff. Incorporating appropriate information into clinic appointments for parents, carers and children could improve the safety and effectiveness of medicines use and also reduce medicines non-adherence.

‘Pill-swallowing training’ for groups of patients with specific chronic conditions was discussed by the nurses and

pharmacists. Mandatory ‘Pill-swallowing training’ for all children of a specific age was reported to be implemented in Australia (no reference was provided with these reports).

The UHCW pharmacist group highlighted the plethora of social issues that prevail in the domiciliary setting, implying that medicines adherence is not always prioritised in some social circumstances.

Medicines adherence

Pharmacists, medical practitioners and nurses reported that dosage form preference is influenced by individual patient choice. The groups contended that parents can influence dosage form choice and medicines adherence in paediatric patients. Reports of parents and carers influencing medicines adherence in paediatric patients were frequently addressed in all groups. This included parents not allowing young people empowerment and also parents not supporting medicines adherence.

The value of rationalising medicines in children who are prescribed multiple medicines (polypharmacy) was proposed by a medical practitioner and BCH pharmacist. On the topic of extemporaneous medicines, the pharmacists reported their unanimous negative attitude towards preparation within community pharmacies and compared this to the rigorous approach adopted within hospital pharmacies. The nurses discussed problems with short expiries of extemporaneous preparations (sodium phosphate and sodium chloride solution), thus leading to inconveniences for parents owing to frequent hospital visits.

Adverse effects of medicines

The medical practitioners and nurses identified key adverse effects of medicines with which they were familiar.

Concerns regarding the safety of excipients were at the forefront of the BCH pharmacist session, with specific reference to propylene glycol, alcohol, sweeteners and sugars.

The supply of medicines and liquid measuring devices and medication errors

Difficulty in freely obtaining oral syringes on the NHS was highlighted by all of the healthcare professional populations. Nurse reports included comments on the reluctance of supply by pharmacists—inferring that this is a financial problem, parents having to purchase oral syringes and the paucity of oral syringe sizes available in the Drug Tariff. A medical practitioner addressed the disallowance of prescribing oral syringes on FP10 prescriptions and reported lack of knowledge regarding whether pharmacists are allowed to freely provide oral syringes or if it is out of their own goodwill.

In addition, the pharmacists highlighted the risks of using inaccurate measuring devices (reports included using a teaspoon).

The UHCW pharmacists perceived that the labelling of liquid medicines should be standardised, for example, labelling all liquid medicines as the weight of drug in the same volume (i.e. X mg in 1 ml). Both healthcare professionals and parents can become confused when different strengths are printed on medicine labels and examples of this were provided by the UHCW pharmacists.

The risk of medication selection errors at GP practices was identified in the UHCW pharmacist focus group.

Problems with medicines at school

Problems with medicines at school were reported across the groups. Unanimous reports suggested that medicines should be prescribed to be administered outside of the school day (where this is possible).

Discussion

Sensory characteristics: taste, texture, size of solid dosage form, and volume were common themes discussed in all of the focus groups. Problems with taste were reported most often. Oral flucloxacillin was highlighted across all groups to be poorly accepted owing to palatability. One study similarly reported that oral flucloxacillin is often considered unpalatable by children and suggested conducting a taste-test with an individual child prior to prescribing flucloxacillin solution [20]. Chloral hydrate solution, prednisolone soluble tablets and Movicol[®] oral powder were all highlighted with respect to taste in two of the focus groups. Similar findings were reported in other studies; oral chloral hydrate [21], and taste of prednisolone oral solution superior to crushed tablets [22].

All healthcare professional groups reported texture as a barrier to medicines administration; particularly amongst children with learning disabilities. Field and co-workers (2003) defined five feeding problems (including one related to the texture of foodstuffs) and explored pre-disposing factors to these problems. Over one quarter of children suffering from Down’s syndrome, autism or cerebral palsy refused to eat food textures that were considered to be developmentally appropriate [23]. Feeding problems (including those related to texture) should be considered carefully by prescribers prior to making prescribing decisions.

The size of solid dosage forms was a common theme highlighted across the groups. Several studies investigating children suffering from HIV support these findings and have reported the negative attitudes of children regarding the size of antiretroviral tablets [24–30].

The nurses shared an in-depth knowledge on oral formulation-related barriers to medicines administration that the medical practitioners and pharmacists did not discuss, highlighting the importance of conducting focus groups with different healthcare professionals. This plethora of knowledge mirrors the ‘hands-on’ experience that nurses have on administering medicines to children. See Table 1 for reports on the variety of formulation-related issues discussed across the groups.

The pharmacists perceived that an improvement to Specials medicines would be ideal. Pharmacists felt that providing Certificates of Analyses to assure the safety and stability of Specials medicines and also licensing some medicines not commercially available in child appropriate formulations should be considered in order to improve medicines for children. Improving Specials medicines was not reported as an ideal medicine improvement by the nurses or medical practitioners, suggesting that this problem is not such a concern for them. Supporting these findings, one study investigated the opinions of GPs regarding off-label prescribing and found that <15 % of GPs admitted to specific concerns when prescribing off-label, including the risk of adverse effects and unevaluated efficacy [31]. Calpol[®] suspension was described positively across all groups; this is supported by previous documentation stating that fruity, sweet formulations are preferred and in general citrus and red berry flavours are favoured across Europe [32]. Pharmaceutical companies should be fully aware of medicines that are generally well-accepted by the paediatric population.

Study findings indicate that paediatric pharmacists’ knowledge on risks of medicines manipulation was better than that of the allied healthcare professionals in this study. This suggests that the knowledge of paediatric pharmacists should be used to guide and educate healthcare professionals when prescribing or administering medicines in paediatric patients. Communication is crucial and each healthcare professional group should be utilised for the wealth of their knowledge, for example it may be beneficial for medical practitioners and nurses to seek advice from hospital pharmacists on drug-foodstuff incompatibilities. To support this, the knowledge and education of paediatric pharmacists should be addressed to ensure that they have optimal understanding of key scientific properties that may affect the dissolution and disintegration of a dosage form, properties including the fat and dairy-protein content, pH and solubility of foodstuffs [12] Such factors, in addition to food affecting gastric emptying rate, risk altering the bioavailability of a drug [33].

A plethora of medicines manipulation techniques were discussed in this study; similar practices have been reported in previous studies [34, 35]. Findings of the focus groups indicate that the participating healthcare professionals were unaware of the level of evidence supporting

various ad hoc manipulation techniques. Similar to the present study, one study observed that the majority of nurses were unaware of potential drug stability and degradation issues when performing ad hoc administration techniques and additionally some nurses were not conscious of a possible impact upon clinical outcome [12]. Further laboratory work is warranted to provide a robust scientific evidence base to support safe and effective medicines manipulation; it should be recognised that existing resources currently exist which provide guidance on medicines manipulation [36, 37].

The risks of medicines interacting (through binding) with nutritional feeds and the potential effects on drug absorption were discussed by the pharmacists and nurses. Examples provided were phenobarbital, phenytoin and ciprofloxacin. Nurses declared their uncertainty regarding how and when to administer the calcium binding drug ciprofloxacin, highlighting that advice is needed when administering medicines and nutritional feeds to optimise therapy. More scientific evidence, based on laboratory work investigating interactions between medicines and nutritional feeds (i.e. identifying potential insoluble complex formation) should be used to direct and standardise pharmaceutical advice in addition to sources that are already available, e.g. [38]. It would be useful to translate this scientific evidence into appropriate sources for nurses and parents and carers.

The pharmacists had greater knowledge and understanding of Specials medicines compared to the nurses and medical practitioners. Similarly, several studies have identified differences in the knowledge on Specials, off-label and unlicensed medicines between allied healthcare professionals [13, 14, 39]. Further investigation is necessary to address the education and support that is needed to improve knowledge of unlicensed medicines, Specials and off-label prescribing amongst healthcare professionals. Educating doctors and allied healthcare professionals on the appropriate use of Specials medicines at degree or equivalent level is fundamental to improving their understanding of unlicensed medicines and optimising safe and cost-effective prescribing practices.

Improving time organisation to permit pharmacists to counsel patients effectively could help to minimise problems that result from poor parental understanding as reported in the focus groups. Pharmacists identified that staff shortages were a barrier to counselling patients. Government funding bodies need to consider this when calculating financial budgets available to the NHS. Several studies investigating solid dosage form training have found improvements in swallowing abilities amongst children diagnosed with HIV [24, 25]. This may help to minimise difficulties with tablet size and also support the use of novel formulations, e.g. mini-tabs [40, 41] in paediatric

patients who would not generally be prescribed a tablet until they are older.

This study identified that family-related factors (including ‘social circumstances’) can influence medicines adherence in children, this is supported by other studies [42–45]. The impact of polypharmacy on medicines adherence requires further investigation. The importance of medicines adherence should be thoroughly explained to parents and children especially in circumstances where an improvement of a chronic condition is not apparent. This may help to discourage parents, carers and young people from discontinuing medicines without consulting healthcare professionals and through this improve medicines adherence.

Study findings suggest that future work should investigate whether incorporating education for parents, carers and young people within clinic sessions, on common and minor adverse effects of medicines to support patients and manage their expectations of medicines has the potential to improve adherence. In addition, concerns regarding the safety of excipients need to be addressed. The draft guideline on pharmaceutical development of medicines for paediatric use [46] reinforced the requirement for pharmaceutical companies to carefully select excipients when formulating medicines for children. The final decision to include an excipient should be evaluated using a benefit to risk ratio of the end pharmaceutical product [47]. It should be recognised that some studies have reviewed stability evidence and provide information regarding formulations and excipients [48, 49].

Issues revealed with the supply of oral syringes on the NHS suggest that the Government should address NHS funding in this area. Concern regarding the use of inaccurate measuring devices needs to be addressed. Household teaspoons can vary between 2 ml and 10 ml and thus using a teaspoon could result in a significant underdose or overdose [50]. Pharmacists should be ensuring that the correct dosing instrument is supplied to all patients and that counselling is provided to parents and carers to assure accurate measurement of a dose.

Standardising the labelling of liquid medicines was reported as a potential method to minimise some dosing errors. Studies are required to investigate if standardising the labelling of liquid medicines could significantly improve patient safety. It is prudent that medicines labelling guidance provided to pharmaceutical companies when applying for a Marketing Authorisation is addressed imminently. Reports that medication selection errors are a problem at GP practices, suggest that safeguarding measures and staff training need to be addressed.

Reports across the groups of some schools refusing to accept responsibility for medicines suggests that medicines policies are not adopted uniformly across schools. Medicines adherence during school hours may be sub-

optimal if schools do not support medicines administration. Omitting doses of medicines during the school day could have a significant impact on clinical outcome, therefore it is critical that medicines administration is addressed correctly in schools. This is especially important for paediatric patients suffering with chronic conditions and those requiring vital acute medicines.

Study limitations

Logistics created the greatest problem when recruiting participants. Time constraints resulting from staff shortages restricted the availability of healthcare professionals and affected study recruitment. A limitation of the focus group study was the low recruitment rate in the UHCW pharmacist group, as this represented more a nominal group. It is acknowledged that group interaction is inevitably minimised with low numbers of participants in a focus group. However, the information gathered from the UHCW pharmacist focus group in collaboration with the BCH pharmacist group widened the scope of pharmacist views in this study.

Although some healthcare professionals in the same setting were known to each other, the nature of this focus group study was not perceived to be threatening; therefore it is unlikely that participants would have contributed in a manner deemed to be more socially acceptable.

The study was conducted at two sites in the West Midlands, UK, therefore it cannot be generalised and viewed as a nationwide perspective. Further investigation is required.

Conclusion

In summary, this study has identified a large number of issues perceived by healthcare professionals to cause problems when administering oral medicines to children, however, these issues are not always considered when using medicines in children. Taste was highlighted as the most significant issue with specific examples, e.g. flucloxacillin solution, being reported across all groups.

Collaboration between doctors, nurses and pharmacists is essential to optimise patient care. Nurses had the greatest knowledge of bedside issues, whilst pharmacists understood the consequences of certain manipulations; wider sharing of this knowledge can help to ensure appropriate medicines are prescribed to minimise issues with administration. Communication is crucial and each healthcare professional group should be utilised for the wealth of their knowledge.

Findings of this study suggest that a paucity of scientific evidence is available to support the many ad hoc

manipulation techniques regularly used. Review of medicines manipulation data available in literature confirmed that a robust scientific evidence base requires further development; this needs to be addressed as it is evident that medical practitioners require more information when prescribing medicines to ensure supply, clinical effectiveness and to maximise cost efficiency.

Addressing the education of healthcare professionals involved in prescribing, dispensing and administering oral medicines to children and additionally counselling provided to parents, carers and paediatric patients will be invaluable to improving the therapeutic treatment of paediatric patients. Protocols detailing best practice guidance need to be developed. Further studies exploring the views of healthcare professionals in different settings would complement this research.

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Conflicts of interest The authors declare that there are no conflicts of interest.

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