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RESEARCH ARTICLE

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Pharmacists' Behaviour when Dispensing Liquid Prescription Medicine for Children: A Quantitative Study

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Abstract

Objectives: This study aims were to investigate community pharmacists' behavior when dispensing a liquid prescription medicine for a child, and identify strategies used or recommended by pharmacists to optimize the dispensing procedure and minimize errors in dispensing. **Methods:** A direct observation (by a researcher) scenario-based role-play method was used. Twenty eight community pharmacies were visited in the inner city region of metropolitan Sydney, accessible to the University of Sydney, and 39 pharmacists were approached. Each pharmacist was visited 3 times with 2 different scenarios being role played during each visit. Participants received performance feedback from the researcher after each visit. Quantitative data were collected using a standardized data collection sheet, on the pharmacists' responses to the scenarios. A score (researcher and pharmacist) was computed reflecting how the pharmacists dealt with each scenario in terms of dosage calculations, questioning and counseling. **Results:** Overall, some pharmacists scored poorly in the dosage calculation tasks, although for many, it appeared that this had improved over time and with researcher feedback. However, our study sample size was not large enough to monitor a statistically significant change in practice over time as a result of the visits and performance feedback. **Conclusion:** This study highlighted a potential gap in identifying and avoiding medication errors due to dose calculations for ambulatory children, which may also be similar for hospital pediatric patients. Accordingly, urgent need for methods to improve such MEs by decreasing the possibility of errors due to dose calculation is a must.

Key words: Child behaviour, Community pharmacist, Dispensing errors, Liquid, Pharmacists, Procedure, Quantitative, Strategies.

INTRODUCTION

Administering medicines correctly and safely is essential for health and wellbeing of children, but it is not always easy to do so. Mistakes such as: inappropriate medicine choice, inappropriate medicine strength and dose, misunderstanding instructions, and inability to calculate and measure the dose accurately, may increase the chance of experiencing unpleasant side effects or reduce the effectiveness of therapy.[1]

Giving prescription medicines to ambulatory children has at least three components (stations) that usually involve three separate people.[1] First the prescriber makes the diagnosis, and prescribes the medicine. Second, the dispenser (usually the pharmacist), reviews the medicine, dispenses the product and provides advice. Third the parent or the carer administers the dose to the child. In addition to these steps, correct storage of the medicine, monitoring of the child's response as well as transferring information back

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to a prescriber to commence the cycle again, if necessary, should be put in consideration. Accordingly, medication errors during any phase of Medication Management Pathway (MMP) could result in underdosing, overdosing or inappropriate dosing frequency.

A study from the US suggested that potential errors which can cause harm to the patient may be up to three fold higher in paediatric populations compared to adults.[2] Unfortunately children face a unique set of risks due to medication errors mostly from inadequate dose calculations. As children's weight and surface areas, especially those for young infants, vary greatly, so dose adjustments may be required as they grow.[3] Calculating an individualized dose is an essential but extra cognitive step that complicates the medicines management process.

According to a study by McPhillips *et al*., about 15% of dosing errors (out of 1933 children with index dispensing events) were equally split between underdose and overdose.[4] Another study found that prescribing errors in 5745 infants' prescription components was 20.8% in dosing frequency and 17.7% in dose strength.[5] A British study suggested that the actual incidence of paediatric dosing errors could be up to 500,000/year in England.[6] Another study found that most medication errors in children were due to dose errors and many doctors could not perform accurate dose calculations.[7] In a multi-centre study in a paediatric hospital the authors found that the prescription errors occurred at a rate of 5.7% and the incorrect dose calculation was the most common error (34%).[8] It was found that the incidence of dose errors, although in adult ambulatory settings, can take place with the prescriber (most commonly) or with the pharmacist during dispensing of the medicine.[9]

Most of the published research has focused on prescriber errors, specifically, dose errors.[1] Few studies have highlighted the pharmacists' errors which mostly have been reported to be due to dose errors. Moreover, there is little research investigating how pharmacists deal with, and resolve medication errors (MEs) caused by prescribers. However, there is no evidence on how this process can be supported in practice and what resources pharmacists need in order to detect and resolve these issues before a child receives his/her medicine. There is therefore a gap in the literature in investigating the role of pharmacists in detecting and resolving medication errors made by prescribers in the community, specifically the cognitive process that they go through. The aim of this study was to investigate and observe community pharmacists' behaviour when dispensing a liquid prescription medicine for a child.

METHOD

Quantitative data collection design (Direct Observation)

We selected the direct observation scenario-based role-play method as it is a suitable method to identify pharmacists' dispensing problems and to evaluate areas of dispensing and counseling which may have patient safety implications.[10]

A Self-assessment and researcher assessment questions

The final data collection sheet consisted of 18 questions that the pharmacist could use to self-assess their performance in the role-played scenarios. The questions were written so as to prompt the pharmacist to reflect on their own performance. By asking them to self-assess, we provided feedback in a non-confrontational manner, in accordance with Miller's concept of motivational interviewing,[11] so the participants could discuss their need to change their practice behaviour without being told what to do by the researchers. The items contained in the assessment were chosen based on the most important questions and counseling points a pharmacist should provide when dispensing the prescription. This was based on the Pharmaceutical Defence Limited's (PDL) recommendations (Guide to Good Dispensing).[12]

The scenario responses were also assessed by the researcher after listening to the audio recorded role-played encounter and reviewing the dispensing label produced. A copy of the self-assessment form was also used by the researcher for the assessment process. This assessment however was not shown to the pharmacist.

Rationale for Selecting and developing scenarios for quantitative study

In order to select the drugs, we obtained sales information data for the most commonly dispensed liquid medications in Australia between May 2005 and June 2010, from the Information Medical Statistics (IMS) (IMS Data Australia 2010). We focused on the last year prior to the start of the study (i.e. May 2009 to June 2010) which was the most relevant period. We selected six products of the most prescribed medications indicated for different diagnoses with different dose regimens and/or concentrations, to allow for variety in the study scenarios. These were Abbocillin® V (Penicillin V), Bactrim® (Trimethoprim), Epilim® (Valproic acid), Flagyl® (Metronidazole), Panamax® (Paracetamol) and Predmix® (Prednisolone) (in alphabetical order). We constructed six different scenarios (one per prescription medication) and wrote simulated prescriptions which contained all relevant information

including: prescriber's name; patient's name and address; date of prescription; prescribed medication, duration, quantity; and prescriber's signature. The pharmacist was provided with two written scenarios randomly selected out of three pairs of prescriptions. The researcher acted as the parent/carer who was visiting a pharmacy to collect a prescription for a liquid medicine for his/her child.

For each visit, two scenarios, one at a time, were presented to the pharmacist. A two week period was chosen between the two visits to the same pharmacist which was found to be suitable for the purpose of this study.[13] The interviews and interactions with each pharmacist were audio-recorded, with the permission of the pharmacist.

Pre-testing of the quantitative method

We pre-tested the prescription scenarios and the data assessment process with 2 academic and 2 non-academic pharmacists by discussing and practicing the scenarios and processes.

Participant selection, sample and sample size

We randomly visited 28 community pharmacies in the inner city region of metropolitan Sydney, accessible to the University of Sydney, and approached 39 pharmacists. As this was a feasibility study, a convenience sample was deemed adequate and sample size calculation unnecessary.

Recruitment

The recruitment process started by approaching the pharmacists in the selected community pharmacies and explaining the study aims and process, and how the pharmacists can help develop future resources to improve the dispensing process for children's medicines. The pharmacists were given the study participant information sheet and consent form. Any concerns raised by the pharmacists were addressed. All pharmacists were informed that they were under no obligation to participate in the study, and that they could withdraw from the study at any time without any adverse implications. At this time the researcher informed all pharmacists that he would act as a carer (child's parent) and the doctor if needed during the role-plays.

A suitable date and time was arranged with the consenting pharmacists, and at each interview, an appointment was made for the subsequent visit. Each pharmacist was visited a total of three times with each visit being approximately two weeks apart.

A brief demographics sheet, regarding the pharmacy location and estimated total number of scripts dispensed/day, working hours and percentage of children's scripts prescriptions, was also been collected at the time of consent.

Conducting the prescription role-plays

Pharmacists quantitative interviews

Before handling each script we reminded the pharmacist of the process, ie; to demonstrate how to dispense a liquid medicine by using the pharmacy dispensing software and reference books (no actual prescription product was physically dispensed); and provide counseling/advice to the parent/carer for the prescribed medicine, for each scenario.

At the end of the simulated dispensing process, we asked the pharmacist to comment on their dispensing and counseling processes for each scenario by completing a blank quantitative self-reported/self-assessment questionnaire. A total of 3 visits for each pharmacist were completed at 2 week intervals apart, using 2 different scenarios, on each occasion, from a bank of 6 scenarios for each pharmacy.

Ethics approval

The Human Research Ethics Committee of The University of Sydney granted approval for conducting this study, including permission to audio record the role played caregiver visits and interviews with pharmacists.

Data Analysis

Quantitative data were analysed using SPSS 18.0 (SPSS Inc, Chicago, IL) for quantitative data analysis.

Data sheet scoring

Directly after finishing dispensing each product, the pharmacist was asked to checklist his/her dispensing process according to the self assessment sheet provided. At the same time, the researcher also completed another copy of the same sheet for the scenario performed by the pharmacist, and confirmed the responses later using the audio-recording of the interaction with the pharmacist participant. This was the researcher-completed sheet and was used to compare and contrast the responses provided by the participants.

The maximum possible score for all scenarios was 36, as we scored Yes=2 marks, Partial=1 and No=0; and there were a total of 18 questions. While for 'Not Applicable (NA)' written by the pharmacist for a question, the entry

was converted to 0 if the pharmacist should have responded to the question, but chose not to. The total score for each interaction was thus expressed as a percentage of the total possible marks applicable for that particular interaction (percentage score).

For SPSS, we added variables in addition to the 18 questions, such as: "My total" is the researcher's total score for pharmacist's assessment; "my total possible score" is the maximum score that can be obtained (i.e. 36); "my percentage" is the (researcher's given score / 36)*100; "pharmacist percentage" (the pharmacist's score / 36)*100, and finally "comparing" is (the pharmacist percentage / my percentage)*100.

Pharmacy / pharmacist demographics

A convenience sample of 28 pharmacies were chosen in the metropolitan area and approached. Only 22 pharmacists in 13 pharmacies agreed to participate (Figure 1). These 13 pharmacies became 12 when a pharmacist (and consequently a pharmacy) withdrew after the 1st interview. After the 2nd interview, another pharmacist withdrew and we interviewed the remaining consenting pharmacists in the same pharmacy. This brought the final number of pharmacists to 20 and the pharmacies to 12. Of the 12 participating pharmacies 9 were standalone pharmacies, 2 were in shopping centres and one was in medical centre. A total of 12 female and 8 male pharmacists participated in this study.

RESULTS

Pharmacies trading hours/day and scripts

We tabulated information about: working hours/day, estimated number of scripts/day in the 12 pharmacies and percentage of children's scripts (as estimated by the participants) (Table 1).

Actual visit time interval

All the pharmacists received three visits from the researcher. The average time interval between visits was 2 weeks, the total study period was approximately 4 weeks.

Quantitativevisits analysis

Individual pharmacist's results averaged across the three visits

The Total Score for each question in the checklist completed by both the pharmacist (as self-assessment) and the researcher assessment have been provided in Table 2. A YES scored 2, a NO scored 0 and a PARTIAL scored 1 (Table 2).

We collected these YES points for the 2 products across the 3 visits for all 20 pharmacists so the maximum possible score is 2 (YES score) X 2 (products) X 3 (visits) X 20 (Pharmacists)=240.

Assessing the dispensing behaviour of pharmacists

The top question asked by the pharmacists was Q11 (using references) and the least question asked was Q16 (providing written information) in the pharmacist's assessment. However, Q1 (asking who the script was for), 10 (checking the dose calculation) and 11 were the top questions asked and Q16 was the least question asked in the researcher's assessment. Overall, pharmacists consistently scored themselves well with Q3 (asking about the child's weight), 10, 11 and 12 (calling the doctor) compared with the researcher's assessment as the ratio was around 100 %. However, they consistently scored poorly (over scoring) with Questions 16 and 18 (Table 3).

Distribution of the products in each visit

In visits 1, Flagyl and Epilim prescriptions were handled 10 times, Bactrim and Predmix prescriptions were handled

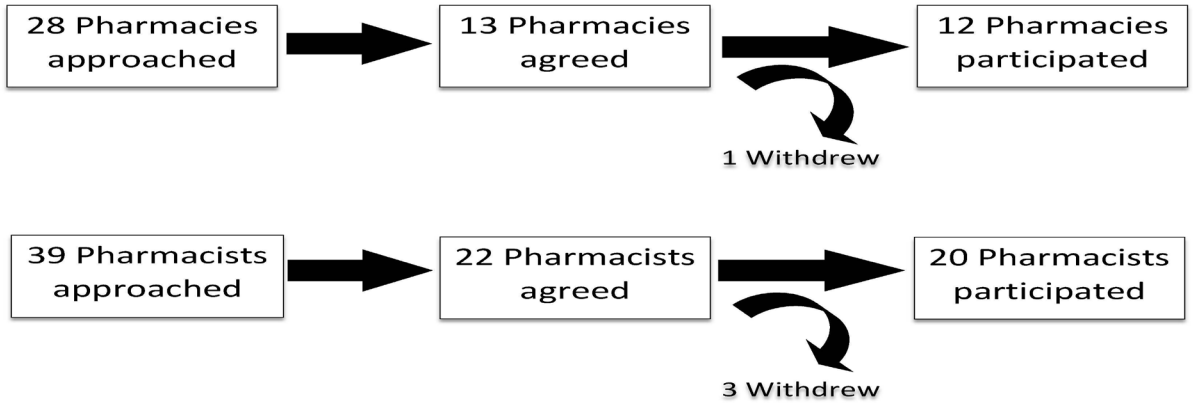

Figure 1: Pharmacies / Pharmacists participation diagram.

Table 1: Pharmacy/Pharmacist demographics

Pharmacy	Number of scripts/day	Pharmacist's Working hrs/day	Percentage of children's scripts (%)
1	150	8.5	30
2*	150	10.5	25
3	40	9	20
4	150	11.5	15
5*	175	10.5	26.5
6*	Missing data	13	1
7	120	8.5	5
8*	250	13.5	50
9	100	14	35
10*	60	11	5
11	Missing data	Missing data	Missing data
12	Missing data	Missing data	Missing data

* Calculated average from estimate data provided by two or more pharmacists in the pharmacy.

Table 2: Total score for each question in checklists answered by "YES", "NO" and "PARTIAL" by both the pharmacist as self assessment and the researcher assessment

Score options	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
Yes (P)	236	230	238	190	124	212	176	150	160	236	238	216	208	194	200	94	194	164
(R)	240	234	238	178	112	206	174	122	156	240	240	218	216	140	226	64	170	112
No	4	10	2	32	110	20	62	86	74	4	0	24	30	30	22	146	42	70
(P)																		
(R)	0	6	2	60	128	34	66	118	84	0	0	22	24	76	14	176	70	128
Partial (P)	0	0	0	18	6	8	2	4	6	0	2	0	2	16	18	0	4	126
(R)	0	0	0	2	0	0	0	0	0	0	0	0	0	24	0	0	0	0
TOTAL POSSIBLE (P)	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
(R)	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240

Pharmacist self assessment (P) and researcher assessment (R).

Table 3: Total average scores for all questions for each pharmacist/product (self assessment and researcher assessment) over the three visits

Q	Pharmacist Assessment Total score (PA)	Researcher Assessment Total score (RA)	Pharmacist percentage (PA/240)*100	My percentage (RA/240)*100	^Comparing (Pharmacist percentage/ My percentage) *100)
1	236	240	98.33	100	98.33
2	230	234	95.83	97.5	98.28
3	238	238	99.16	99.16	100
4	199	179	82.91	74.58	111.16
5	127	112	52.91	46.66	113.39
6	216	206	90	85.83	104.85
7	177	174	73.75	72.5	101.72
8	152	122	63.33	50.83	124.59
9	163	156	67.91	65	104.47
10	238	240	99.16	100	99.16
11	239	240	99.58	100	99.58
12	216	218	90	90.83	99.08
13	209	216	87.08	90	96.75
14	202	152	84.16	63.33	132.89
15	209	226	87.08	94.16	92.48
16	94	64	39.16	26.66	146.88
17	196	170	81.66	70.83	115.29
18	167	112	69.58	46.66	149.12

^100% means that the pharmacist's self-assessment score matched that of the researcher. A higher than 100% score means that the pharmacist scored himself/herself higher than the researcher; and a lower than 100% score means that the pharmacist scored himself/herself lower than the researcher did. Dividing by 240 is because there are 2 maximum score for each question 6 products per Pharmacist and 20 Pharmacists in total=2*6*20=240.

Table 4: Distribution of the products in each visit with the percentage of comparing the pharmacist assessment to researcher assessment

Number of visits	Flagyl visit 1*	Flagyl visit 2	Flagyl visit 3	Epilim visit 1	Epilim visit 2	Epilim visit 3	Bactrim visit 1	Bactrim visit 2	Bactrim visit 3	Predmix visit 1	Predmix visit 2	Predmix visit 3	Panamax visit 1	Panamax visit 2	Panamax visit 3	Abbocillin –V visit 1	Abbocillin –V visit 2	Abbocillin –V visit 3	Total
1	127.8	100	100	88.46	100	100	100	81.25	97	100	100	100	94	106.4	107.23	106	124.36	110.84	
2	100	107.69	100	100	103	100	109.1	107.7	86.65	125	118.52	115.28	81.97	104.9	114.1	112	100	106.41	
3	108.3	116.67	120	115.4	106	109.09	108.3	100	100	100	97.14	94.68		105.6	100		94.68	103.19	
4	100	100	145	100	91	138.46	100	100	115.28	106.67	107.69	113.25		115.3	100		123.88	86.75	
5	112		100	106.7		100	100	109.1	127.87	100	100	120.48		138.6	100		106.38	100	
6	108.3		100	123.1		91.67	110	123.1		106.9	100			118	105.62		100	93.06	
7	122.2			78.57			125	120		107.69	128.57			100	116.28		107.23	120.48	
8	106.7			106.3			96.15			100				123	112.36		111.94	116.4	
9	112			100										127.9	108.33		132.84	100	
10	121.7			116.67															
Total	1119	424.36	665	918.4	400	639.22	848.6	741.1	526.8	846.26	751.92	543.69	175.97	1040	963.92	218	1001.31	937.13	
Average	111.9	106.1	111	91.84	100	106.54	106.1	105.9	105.36	105.78	107.42	108.74	87.99	115.5	107.1	109	111.26	104.13	105.64

100% means that the pharmacist's self-assessment score matched that of the researcher. A higher than 100% score means that the pharmacist scored himself/herself higher than the researcher did; and a lower than 100% score means that the pharmacist scored himself/herself lower than the researcher did

8 times, and Panamax and Abbocillin-V prescriptions were handled 2 times.

In visits 2, Flagyl and Epilim prescriptions were handled 4 times, Bactrim and Predmix prescriptions were handled 7 times and Panamax and Abbocillin-V prescriptions were handled 9 times.

In visits 3, Flagyl and Epilim prescriptions were handled 6 times, Bactrim and Predmix prescriptions were handled 5 times and Panamax and Abbocillin-V prescriptions were handled 9 times.

Table 4 showsthe distribution of the products in each visit and comparing the pharmacist assessment to researcher assessment percentage.

On further examination of questions scoring well or poor with particular products, it was apparent that the top and least question answered per product were as follows;

For Flagyl: Highest score were Q 1, 3, 10 & 11. And lowest score was Q5

For Epilim: Highest score were Q 1, 10, 11 & 12. And lowest score was Q16

For Bactrim: Highest score were Q 1, 2, 3, 6, 10, 11, 12 & 13. And lowest score was Q5

For Predmix: Highest score were Q 1, 2, 3, 10, 11, 12, 13 & 15. And lowest score was Q16

For Panamax: Highest score were Q 1, 2, 3, 4, 10 & 11. And lowest score was Q16

For Abbocillin-V: Highest scores were Q 1, 2, 3, 10, 11 & 15. And lowest score were Q 5 and 16.

Interestingly, the questions about child's age and weight (Q2 & 3) were commonly asked with all products except Epilim. While Bactrim was the only product where Q6 (what the doctor had said?) scored the highest. In addition, highest verbal counseling (Q15) was provided when Predmix and Abbocillin-V were handled.

Looking at the pharmacists scores in asking the patient the essential questions and their actions during dispensing, we can generally classify the questions to:

Non problematic questions

Q1 (asking about who the script was for), 3 (child's weight), 10 (check the dose calculation) and 11 (using references)

have been consistently asked by the pharmacists, while Q2 (child's age), 15 (providing verbal counseling), 12 (calling the doctor), and 13 (changing the dose) were frequently asked.

Problematic questions

Q16 (providing written information) was the least one asked followed by Q5 (when the symptoms have started), 18 (showing how to use the device) and 8 (other medical conditions).

Three visits analysis

The ratios of the pharmacists' self-assessment score to researcher's assessment score and the average for each visit.

Demonstration of motivational interviewing

The self-assessment sheet enabled participants to verbalise their need to change practice, as per Miller's concept of motivational interviewing. A common area for behavioural change was in information gathering and calculating the dose to the patient.

Participant perceptions of self-assessment

Much positive feedback was received about the self-assessment sheet, as it highlights new knowledge and serves as a reminder of protocols

DISCUSSION

The aims of this study were to investigate community pharmacists' behaviour when dispensing a liquid prescription medication for a child. In this study, we observed how 20 pharmacists dispensed 6 different liquid prescription medications for the proposed scenarios.

The Inter-rater agreement between researcher and self-assessment data has revealed differences in agreements. Participants suggested that these differences may be due to the subjectivity of self-assessment, where some pharmacists may judge themselves harder or more leniently than the researcher. This highlights how important it is for the pharmacists to ask about the child's weight at all times. On the other hand, providing verbal counseling was of ultimate concern of the pharmacists and if not provided they would feel unsatisfied and they were fully aware of its significance. This was clear when 9 answers for Q15 were pharmacists ticked "PARTIALLY" by the pharmacists while they have provided adequate verbal counseling by the researchers scoring and should have answered "YES" (Table 2). On the contrary, some pharmacists were confident that they have provided adequate demonstration on how to use the device and answered "YES" (82 times for Q18) of which 26 should have been answered "PARTIAL" or "NO". This has brought the comparing score to less than 100%.

Furthermore, when comparing pharmacist self assessment and the researcher assessment scoring (percentage average across the three visits), we found the two sets of scores to be similar for the first and third visits. However, the scores for both self and researcher assessments were higher in the second visit which may reflect an improvement in the process of dispensing (e.g. following the ideal dispensing procedure), having discussed the dispensing process with the pharmacist in the first visit. This was probably followed by an increase in self confidence in the last visit which may have lead to a drop in the pharmacists' performance and hence, a decrease in the average for the last visit.

For the distribution of the products in each visit, we can see some trends with different drugs handled by the pharmacists. For example for Flagyl, the pharmacists have always (in all 3 visits) scored themselves either similar or higher than the researcher while for Epilim and Panamx, pharmacists seemed to score themselves less than the researcher in the first visit, then equal or more than the researcher in the 2nd visit, then again less but still more than the researcher in the last visit. While the trend for the average of the 3 visits for each of Bactrim, Predmix and Abbocillin-V was that the pharmacist has scored him/her-self more than the researcher has done. There does not seem to be any clear understanding of the trends of the agreements looking at the actual medication. Furthermore, as shown in the problematic and non problematicquestions analysis, these non problematic questions may be on the top of the priority list of the pharmacists as by answering these short answer questions (Q1, 3, 2) and doing these quick yet significant checks or actions (Q10, 11, 15, 12) the pharmacist can confidently dispense the medication with minimal or no harm. While some may find that providing written information or opening a discussion about previous medical history or start demonstrating how the device should be used may end up with unnecessary information and time consumption.

From products point of view, the pharmacists' behaviour was different to some extent when it came to more serious drugs like Predmix and Epilim which were the top 2 ranking products regarding number of questions answered. This may reflect that pharmacists were more cautious and careful in dispensing these medications. While relatively safer products like Flagyl and Panamax had the lowest average of total score by researcher due to possibly more relaxed handling by the pharmacists.

Future work will need to focus on using the role play (simulated patient) methodology and with a larger and representative sample of community pharmacists to evaluate their dispensing processes and counseling practices. Moreover, based on the findings of this study, it is important to develop and evaluate strategies which optimize the dispensing of liquid prescription medicines for children, and which prevent any errors occurring, as defined within the Medication Management Pathway.

Limitations

There were some limitations in this study which may have an impact on the data collected. Therefore, the findings of the study should be interpreted with these limitations in mind. Firstly, it is possible that the direct observation of the pharmacists may have had an impact on the way the pharmacists responded to the scenarios. It is possible that they took extra care when dispensing the prescriptions and/or questioning the observer; and provided more information during counseling of the observer. Secondly, not all pharmacists were available for all three visits, and therefore there were some incomplete data sets. Thirdly, the two week gap between visits may not have been long enough for the pharmacists to forget the study questions, and this may have had an impact on subsequent visits and performances.

CONCLUSION

The use of simulated patient scenarios in community pharmacy practice to assess and improve dispensing prescription liquid dosage forms for children was a feasible method. Of particular importance, is the acceptability of the self-assessment component of immediate performance feedback delivery, as it allows participants to evaluate their own skills and knowledge, highlight areas that need change. This was further reflected by the strong agreement between the researcher and participants when comparing assessments of their performance which reflects their understanding of the study assessment process.

This method is useful in utilizing key psychology principles associated with behavioural change. Pharmacists were more cautious and careful in dispensing more serious drugs like Predmix and Epilim while relatively more relaxed in handling safer products like Flagyl and Panamax. In our opinion this is a cautious practice.

This study has revealed the gap in discovering and avoiding medication errors due to dose calculations for ambulatory children and there is an urgent need for methods to up-skill pharmacists and improve their practice and decrease the possibility of errors due to dose calculations.

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CONFLICT OF INTEREST

None.

ABBREVIATION USED

AMH Australian Medicine Handbook; BEACH Bettering the Evaluation And Care of Health; CHRMC Clinic at Children's Hospital and Regional Medical Center; CPOE Computerized physician Order Entry; IMS Information Medical Statistics, MEs Medication errors; MIMs Medical Information Management system; MMP Medication Management Pathway; NCHS National Center for Health Statistics; OHME Out-of-Hospital Medication Errors; PDL Pharmaceutical Defence Limited; PCC Poison Control Centers; QUM Quality use of medicines; VPIC Victorian Poisons Information Centre.

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