

Interprofessional Approach to Educating Medical Students on Pediatric Medication Taste and Palatability

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Abstract

INTRODUCTION Medication palatability is one of many factors influencing medication adherence in the pediatric population, but there is limited research into medical students' knowledge of this relationship. The purpose of this study was to assess the knowledge and beliefs of medical students regarding pediatric medication characteristics, administration, taste, and effect of palatability on adherence before and after an interprofessional education session.

METHODS Pharmacy colleagues taught a lecture addressing pediatric pharmacology, patient cases, medication administration strategies, and methods to enhance adherence. Participants had the opportunity to taste amoxicillin, cefdinir, clindamycin, prednisolone, and ranitidine. Students completed a survey before and after the education session, and a poll during the taste test.

RESULTS Prior to the session, students had very few lecture hours devoted to these topics and the majority were unfamiliar with medication flavoring and administration to children. After the session, 94% of students stated their opinion on the importance of medication palatability had changed. There was a significant improvement in students' beliefs about their pharmacology knowledge ($p < 0.0001$). Additionally, 40% changed their patient counseling habits after the session.

DISCUSSION Taste heavily influences pediatric medication adherence, and studies show physicians who taste the medications they prescribe have altered their practices based on that experience. Additionally, interprofessional collaboration between pharmacists and providers is beneficial for both parties as well as patients and the healthcare system.

CONCLUSION This study shows an interprofessional education session effectively teaches medical students about pediatric medication taste, adherence, and pharmacology.

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Implications for Interprofessional Practice

- Exposure to interprofessional collaboration during the clinical years of medical school allows students to utilize prior knowledge from pre-clinical lectures in conjunction with clinical judgment gained during the clinical years to fully benefit from an education session.
- The findings from this study add to the literature by showing an interprofessional approach is an effective method of teaching future providers about pediatric medication taste, adherence, and pharmacology.
- This study highlights the need for future research utilizing interprofessional collaboration between pharmacy and medical educators to teach medical students about various topics and whether that motivates students to incorporate interprofessionalism into their future careers.

Introduction

In this study, we utilized an interprofessional education session in which pharmacists, pharmacy residents, and pharmacy students taught third- and fourth-year medical students about pediatric medication characteristics, administration, and adherence. Through survey data completed before and after the education session, we sought to determine whether this interprofessional approach was an effective method of teaching these topics. Additionally, we investigated whether the students' beliefs regarding medication adherence and counseling practices changed after the didactic session and taste testing of several common pediatric medications.

Literature Review

In the United States between 2015 and 2016, an estimated 18% of children aged 0-11 years, and 27% of adolescents aged 12-19 years used a prescription medication within the last 30 days of polling (Martin, Hales, Gu, & Ogden, 2019). In 2018, the Center for Disease Control (CDC) found there were 56.2 million outpatient antibiotics prescribed to children less than 20 years old ("Outpatient Antibiotic Prescriptions," 2020). However, a survey distributed to parents at an outpatient pediatric practice found approximately one-quarter of patients surveyed did not complete the full-course of antibiotics prescribed to them (Sunakawa, Akita, Iwata, Sato, & Fujii, 1995). In addition to safety and health consequences associated with decreased medication adherence, it can also be costly to the healthcare system, patient, and family. The losses

secondary to medication non-adherence include expenses related to office visits, hospitalization for possibly preventable consequences, time off work, treatment of adverse effects, and alternate childcare fees (Baguley, Lim, Bevan, Pallet, & Faust, 2012; Brixner, 2005). Additionally, poor adherence to antibiotic regimens incurs epidemiological costs related to the development of drug-resistant bacteria (Baguley et al., 2012; Wu & Roberts, 2008). Given the sheer number of medications prescribed to children every year, it is especially important for providers to understand the challenges of medication administration and to pursue any means to improve adherence.

Although medication non-adherence is not unique to pediatrics, there are some elements that contribute more in children compared to adults, such as palatability and formulation (al-Shammari, Kohja, & al-Yamani, 1995; Baguley et al., 2012; Brixner, 2005; El-Rachidi, LaRochelle, & Morgan, 2017; Gardiner & Dvorkin, 2006; Paranthaman, Kumarasamy, Bella, & Webster, 2009; Rodriguez, Weiss, & Copp, 2011). When asking parents why they may have discontinued a medication regimen before the specified time, one of the top reasons cited was their child refused to take the drug (Wu & Roberts, 2008). In a survey of a different outpatient practice, one of the most frequent reasons for non-adherence was a "bitter taste" of the prescribed medication (al-Shammari et al., 1995). Multiple studies have found a direct association between a child's taste perception of a medication and adherence to the prescribed therapy (Cohen et al., 2009; Dagan, Shvartzman, & Liss, 1994). Additionally, while complexity and duration of a prescription

are characteristics of treatment regimens that are not specific to pediatrics, they can largely influence adherence in this population (Brixner, 2005; El-Rachidi et al., 2017; Gardiner & Dvorkin, 2006; Paranthaman et al., 2009).

While there are many other factors which influence pediatric medication adherence such as cognitive development, peer pressure, side effects, family structure and support, caregiver satisfaction, provider counseling, cultural barriers, and socioeconomic status, one of the most pervasive and easiest to address is palatability (Brixner, 2005; El-Rachidi et al., 2017; Gardiner & Dvorkin, 2006). The linkage between palatability and medication adherence is well-established in the literature, but there is limited research into medical students' knowledge of medication taste and the importance of palatability in pediatric treatment adherence. The purpose of this study was to assess medical students' knowledge and beliefs about pediatric medication administration, palatability, and adherence before and after an interprofessional education session. Our main objective was to measure the effectiveness of an interprofessional education session on teaching pharmacology and medication adherence in the pediatric population. A second objective was to analyze the effects of an interactive taste test on student's perceptions of medications and their patient counseling habits. We hypothesized there would be a difference in self-perceptions of pharmacology knowledge and importance of palatability of pediatric medications between the pre- and post-survey responses and that there would be a change in some students' practices as a result of this education.

Methods

This was an IRB-approved (HP-00075530) retrospective observational study conducted at a single-site urban academic institution from September 2017 to February 2020. The participants included were medical students participating in their pediatric core clerkship at this institution. Participation was voluntary; some students opted out due to effects of medications, allergies, pregnancy, and/or preference not to participate. A total of 313 participants were included in over a total of 22 sessions, averaging 19 students per session. Prior to an education session, students

completed a survey (Table 1) regarding demographics, perception of pharmacology knowledge, beliefs about medication taste, adherence concerns, and familiarity with flavoring and administration of medications to children. This was a pen and paper survey that was distributed to the class immediately preceding the session. After completion of the survey, students participated in an interprofessional education session where pharmacists, pharmacy residents, and pharmacy students from a local pharmacy school and affiliated medical center taught a lecture covering pediatric pharmacology, patient cases, medication administration, and methods to enhance adherence. The pharmacology component covered drug classes, mechanism of action, common adverse effects, black-box warnings, and pediatric-specific pharmacokinetics. Patient cases were utilized during this component to further emphasize the topics being taught. The adherence component of the lecture provided students with strategies to mask medication taste which they may utilize in their future counseling of parents and patients. This included the use of cold foods to mask tastes or alternative foods to serve with medication, in addition to flavor sprays that are safe and effective. Strategies were also reviewed to administer tablets or capsules in other forms, such as sprinkling onto food when pharmacologically stable, and the use of flavoring by pharmacists.

After completing the lecture component of the session, students were given the option to taste test five common pediatric medications with varying taste profiles: amoxicillin, cefdinir, clindamycin, prednisolone, and ranitidine. Students then completed a Kahoot!® survey to provide their opinion of the medication taste: (1) It tasted the best; (2) It tasted the worst; (3) It was good, but wasn't the best; (4) It was bad, but wasn't the worst. Following this activity, students were emailed a post-survey (Table 1) including the same question from the pre-survey regarding perception of pharmacology knowledge. This survey also included questions about recall of medication taste, qualities associated with remembering certain medications, and how students' counseling approach will change after completing this session. The content of the pre- and post-surveys were predetermined by the co-investigators as comprehensive and easy to answer by the student participants.

Table 1. Surveys administered to medical students before and after the interprofessional education session

Pre-survey: 313 total responses		Post-survey: 70 total responses	
Variable	No. (%) of Participants	Variable	No. (%) of Participants
Rate your knowledge of pediatric pharmacology		Rate your knowledge of pediatric pharmacology	
<i>(p < 0.0001)</i>		<i>(p < 0.0001)</i>	
Extremely knowledgeable	0 (0%)	Extremely knowledgeable	1 (1%)
Very knowledgeable	0 (0%)	Very knowledgeable	2 (3%)
Moderately knowledgeable	32 (10%)	Moderately knowledgeable	30 (43%)
Slightly knowledgeable	174 (56%)	Slightly knowledgeable	34 (49%)
Not at all knowledgeable	106 (34%)	Not at all knowledgeable	3 (4%)
Is taste or palatability of pediatric medications important to you?		This lecture changed my opinion of the importance of palatability and taste of medications.	
Yes	227 (73%)	Completely agree	29 (42%)
No	12 (4%)	Agree	36 (52%)
Maybe	73 (23%)	Neither agree nor disagree	4 (6%)
Completely disagree		Disagree	0 (0%)
			0 (0%)
Are you familiar with flavoring of pediatric medications?		Was there a particular medication(s) you remember from the taste test?	
Yes	50 (18%)	Yes	62 (89%)
No	232 (82%)	No	8 (11%)
Which of the following components are likely to contribute to pediatric medication adherence? Select top 3 choices		If answered yes to previous question, which medication(s)?	
Taste/palatability	255 (31%)	I do not remember	8 (8%)
Frequency of administration	191 (23%)	Amoxicillin	33 (31%)
Cost	136 (17%)	Prednisolone	37 (35%)
Formulation	105 (13%)	Ranitidine	16 (15%)
Smell	70 (8%)	Cefdinir	8 (8%)
Volume, if liquid	37 (4%)	Clindamycin	3 (3%)
Color	14 (2%)		
Knowledge of indication	13 (2%)		
Taste and palatability affect patient medication compliance and adherence.		Why did you remember the medication(s)? Check all that apply	
Completely agree	213 (76%)	Good taste	40 (38%)
Agree	63 (22%)	Bad taste	55 (53%)
Neither agree nor disagree	5 (2%)	Good smell	5 (5%)
Disagree	0 (0%)	Bad smell	0 (0%)
Completely disagree	1 (0%)	Other	4 (4%)
Are you familiar with how to administer oral medications to children?		Have your patient counseling habits changed since the lecture and taste test?	
Yes	86 (31%)	Yes	28 (40%)
No	195 (69%)	No	42 (60%)

Table 1. (cont'd) *Surveys administered to medical students before and after the interprofessional education session*

How many previous lecture hours have you had on medication administration, taste, or palatability?	
No lecture hours	190 (62%)
1-3 lecture hours	111 (36%)
4-6 lecture hours	3 (1%)
6-10 lecture hours	2 (1%)
>10 lecture hours	1 (0%)
Gender	
Male	131 (42%)
Female	182 (58%)
Are you a parent or caregiver for any children?	
Yes	13 (4%)
No	299 (96%)
If answered yes to previous question, have you given your child(ren) any medication in the past year?	
Yes	11 (85%)

For data analysis, the pre-survey, post-survey, and Kahoot!® survey responses were uploaded into a spreadsheet by the co-investigators. The surveys were anonymous and therefore did not need to be de-identified for analysis. Statistical analysis was performed by one of the investigators and compared categorical variables using a two-sample t-test. We considered survey responses before and after the education session. All statistical tests used were two-sided, and $p < 0.05$ was used to indicate statistical significance.

Results

The responses for the survey completed before the education session are depicted in Table 1. The gender distribution of participants in this study is aligned with the demographics of our institution's typical medical school class. The overwhelming majority of participants were not parents or caregivers. Prior to the lecture, students had minimal, if any, lecture hours devoted to medication administration, taste, or palatability. 90% of students felt slightly or not at all knowledgeable about pediatric pharmacology (Figure 2). When asked whether taste or palatability was important to them, almost 30% of participants said "no" or "maybe." When asked to identify the components most likely to contribute to pediatric medication adherence, the top three answers were taste/

palatability, frequency of administration, and cost. Even though 98% of participants believed taste and palatability affect medication adherence, only 18% were familiar with flavoring of pediatric medications and 31% knew how to administer oral medications to children.

A Kahoot!® survey was utilized to poll participants during the medication taste test component of the session and the results are shown in Figure 1. Among students who completed the poll, 47% believed prednisolone tasted the worst. Students thought amoxicillin tasted the best and ranitidine was bad, but wasn't the worst tasting. Beliefs about cefdinir and clindamycin were mixed.

The responses completed after the education session are compiled in Table 1. 93% of students who completed this survey agreed the lecture changed their opinion on the importance of palatability and taste of medications. When rating their knowledge of pediatric pharmacology, 43% of students felt they were moderately knowledgeable and 49% felt slightly knowledgeable, which is statistically significantly improved from the pre-survey responses ($p < 0.0001$; Figure 2). 89% remembered at least one medication from the exercise, most often due to taste (good or bad) rather than smell. 40% had a change in their patient counseling habits after the session.

Figure 1. Kahoot!® survey of medical students' perceptions of five common pediatric medications administered during the taste test

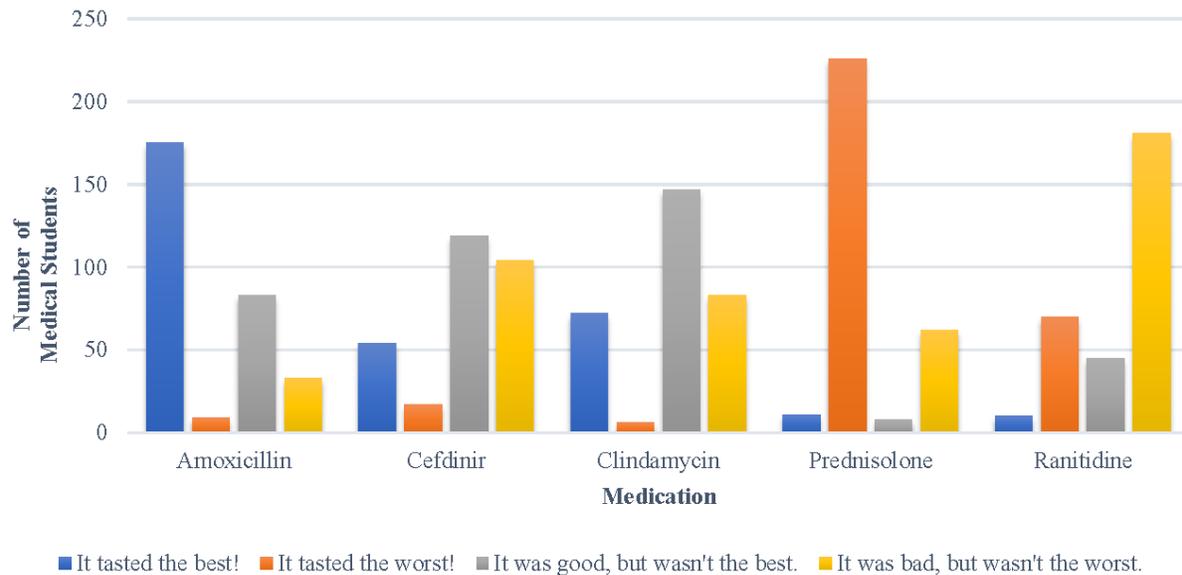


Figure 2. Comparison of survey responses to “Rate your knowledge of pediatric pharmacology.” Students could rate their knowledge from “extremely knowledgeable” to “not at all knowledgeable.” The response distribution before the education session is on the left, and after the session is on the right. ($p < 0.0001$)



Discussion

It is well-established in the literature that palatability of medications heavily influences adherence to treatment regimens in the pediatric population (al-Shammari et al., 1995; Baguley et al., 2012; Brixner, 2005; El-Rachidi et al., 2017; Gardiner & Dvorkin, 2006; Paranthaman et al., 2009; Rodriguez et al., 2011). Caregivers are significantly more likely to adhere to the prescribed regimen if they believe their child has a positive reaction to the medication (Dagan et al., 1994; Sunakawa

et al., 1995). Some researchers have noted this association and stated that medications with significantly lower taste ratings should not be prescribed (Matsui, Barron, & Rieder, 1996). In this study, even prior to an education session emphasizing the correlation between taste and adherence, many medical students expressed recognition of this relationship at baseline. After listening to a lecture and personally tasting several medications, students endorsed a change in their opinion regarding the importance of palatability and taste. Based on these results, an interprofessional education

exercise underscoring the significance of the relationship between medication taste and adherence may enhance training for prescribing preferences for students who previously have not recognized the importance of this matter. This could be especially impactful in situations where a provider has equally effective medication choices for similar diagnoses which are mainly differentiated by their taste, such as antibiotics.

One of the components of this study was a medication taste test which provided first-hand experience to students. We found this activity helped almost 90% of participants remember one or more medications, most often due to good and/or bad taste. Most participants agreed amoxicillin tasted the best, which aligns with the findings of other studies (Dagan et al., 1994; Steele et al., 1997). They also believed prednisolone tasted the worst of the five medications. Although there is an abundance of studies investigating antibiotic taste, there is limited research into taste of other classes of medications, making it difficult to draw any conclusions from our findings. Additionally, several studies investigating medication taste reactions have utilized adult subjects, including ours, but taste preferences have been shown to differ between adults and children (Ivanovska, Rodemaker, van Dijk, & Mantel-Teeuwisse, 2014; Mennella, Reed, Roberts, Mathew, & Mansfield, 2014). Consequently, even though our study shows how a taste test can influence how students remember medications, it's also important to emphasize there may not be a direct relationship between the taste preferences of a provider and their pediatric patients.

After this education session, our hope is students will take this new knowledge of pharmacology, adherence, and medication taste to enact change in their future practice. 40% of students believed their patient counseling habits changed after the lecture and taste test. Multiple studies have demonstrated that physicians who taste the medications they are prescribing have altered their practices based on that experience (Bradshaw et al., 2016; Gee & Hagemann, 2007). Although medication taste is an important factor influencing adherence, so is patient/parent-doctor communication. Brookes-Howell et al. (2014) showed parents are more likely to adhere to a treatment regimen if there is established trust with the physician, continuity of care, and if they believe the provider openly communicated with them when making the prescribing decision. The lec-

ture component equipped students with knowledge to prepare parents for common adverse effects and various strategies to help disguise medication taste in order to increase the likelihood of adherence.

Our study utilized an interprofessional education approach where pharmacists, pharmacy residents, and pharmacy students taught medical students during their pediatric core clerkship. A similar study conducted by Chan, Doroudgar, Huang, and Ip (2020) investigated the effectiveness of a peer-to-peer program where a pharmacy student taught first-year medical students about medication adherence. When assessing medical students' knowledge regarding adherence, they found significant improvement in scores after the program (Chan et al., 2020). A different program had pharmacy and medical students working together to obtain a patient history, which was deemed a success when almost all students after the session believed working with the other discipline was useful (Greene, Cavell, & Jackson, 1996). Our study supports these findings since we found a significant difference in student's beliefs about their pharmacology knowledge before and after the session. The main difference between our study and the aforementioned ones is we specifically targeted third- and fourth-year medical students. At our institution, the first and second years of medical school are mainly didactic sessions where students gain pharmacology, physiology, and pathology knowledge in a classroom with limited clinical exposure. During the third and fourth years of medical school, students gain hands-on, practical experience where they learn patient counseling strategies and gain clinical judgment. By implementing this education session during this time frame, students were able to utilize prior pharmacology education from their pre-clinical training and their clinical strategies learned throughout the later years of medical school to optimize learning from this interprofessional training session.

Outside of the education realm, interprofessional collaboration between pharmacists and physicians produces better patient outcomes and lower healthcare costs (Aguilar et al., 2016; Matzke, Moczygemba, Williams, Czar, & Lee, 2018). Successful collaboration between pharmacists and general practitioners has also been shown to improve medication adherence (Rathbone, Mansoor, Krass, Hamrosi, & Aslani, 2016). Pharmacists have a unique opportunity to educate both

future and current clinicians, allowing them to better counsel their patients and patient's families. Parents who are properly counseled have a significantly lower rate of errors in medication administration compared to those who are not counseled (El-Rachidi et al., 2017). Wu and Roberts (2008) found medication adherence is best obtained through a combination of behavioral and educational interventions, so even if medication taste is changed it may not make a difference unless physicians are properly equipped with the knowledge to educate patients and their caregivers. We believe our interprofessional education session was mutually beneficial because it provided the medical students with information regarding pharmacology and adherence strategies while also providing the pharmacy students and residents with hands-on experience to practice their teaching skills to future providers. Based on the success of previous studies and this current study, we believe an interprofessional approach enhances the educational experience, prepares students to counsel families, and hopefully motivates students to incorporate interprofessionalism into their future careers.

Despite the robust sample size and interprofessional education component, our study did have several limitations. The content of the pre- and post-surveys were determined by the co-investigators to be comprehensive and appropriate for the objectives of this study, but a pilot test for face validity was not performed. Regarding the surveys, although we had a total of 313 responses to our pre-survey, only 70 responses to the post-survey were submitted and therefore our results may be influenced by selection bias. The post-survey was administered via email after students left the session, which is likely the cause of the low response rate. This could be prevented in future studies by administering the survey in-person at the end of the session. Another limitation was data about medication taste could potentially be influenced by prior medication taste experiences. Lastly, care should be taken when trying to extrapolate a child's taste preferences from these data due to potential difference in preferences from adults. Future research should be directed at following students long-term to see how they utilize this information in their future practices and compare them to students who learned this information in a traditional lecture format versus our interprofessional approach. Additionally, future studies could explore the relationships between students of different disciplines and how an interactive education session impacts those

relationships in future collaborations. Perhaps students bonding over a medication taste test or similar activity could forge strong working relationships that benefit both parties and their patients in their future careers.

Conclusions

Through a focused interprofessional education session, students' perception of their pharmacology knowledge was significantly improved. Tasting several common pediatric medications changed students' opinions on the importance of palatability in a pediatric population and may be a useful strategy for influencing their future prescribing patterns and advising. Implementing this session during a core clerkship in the clinical years of medical school allows students to utilize previous pharmacology education from pre-clinical years with their clinical judgement gained in the third and fourth years of medical school to optimize this interprofessional learning experience.

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