Characteristics of Pediatric Clinical Interventions Documented by a School of Pharmacy

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OBJECTIVES Documentation of interventions by pharmacists has become a standard of practice in clinical practice sites. Pharmacists' interventions in pediatric practice settings for short periods of time have been reported in the literature. A single study has described faculty and student interventions in the pediatric setting. The objective of this study was to characterize 4 years of interventions by faculty and students of a school of pharmacy that occurred at various pediatric practice sites throughout a state.

METHODS Pharmacy practice faculty and fourth year student pharmacists are required to document clinical interventions during advanced pharmacy practice experiences. Interventions are documented in a single, commercially available, Web-based system. Reports of interventions with cost avoidance at pediatric inpatient and outpatient practice sites throughout a state from 2011 to 2014 were collected and analyzed. Data were sorted based on year, practice site, type, and number of activities and interventions, and estimated cost avoidance.

RESULTS Two full-time faculty members practiced in pediatrics and, on average, 25 students entered interventions at pediatric sites each year. A total of 12,784 interventions were documented by faculty and students over the 4-year period, with students entering 81.8% of the interventions and 69% occurring in the inpatient setting. Total cost avoidance for all 4 years was \$1,684,609. The most frequent interventions were patient medication history, patient counseling, allergy information clarified, drug therapy adjusted, and drug information.

CONCLUSIONS Pharmacy faculty and students documented various types of clinical interventions in the inpatient and outpatient pediatric settings and demonstrated a positive impact at pediatric practice sites throughout a state, as well as cost avoidance in the associated healthcare systems.

ABBREVIATIONS ADE, adverse drug event; ADR, adverse drug reaction; APPE, advanced pharmacy practice experience; DVT, deep vein thrombosis; IV-to-PO, intravenous to oral; OTC, over-the-counter; PA, prior authorization; PICU, pediatric intensive care unit; PK, pharmacokinetic; TPN, total parenteral nutrition

KEYWORDS adverse drug reactions; faculty; interventions; pediatrics; pharmacist students

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Introduction

Documentation of interventions by pharmacists has become a standard of practice in clinical practice sites. Schools of pharmacy may require or request practice faculty and students document patient interventions to demonstrate their value at their clinical practice sites.^{1,2} Characteristics of interventions made by pharmacists in various pediatric clinical practice settings for a short period of time have been reported in the literature.³⁻⁸ One 8-month study described interventions by a single faculty member in a pediatric intensive care unit (PICU).⁹ However, only one study, published in 2004, reported faculty and student interventions over a 1-year period in the pediatric setting.¹⁰ Studies that evaluate the impact of faculty and student interventions over a long-term period are lacking. In addition, most studies evaluate a single center or institution. The objective of this study

was to characterize 4 years of interventions documented by full-time faculty and students of a school of pharmacy that occurred at multiple pediatric clinical practice sites throughout the state.

Materials and Methods

In this school of pharmacy, pharmacy practice faculty and fourth year student pharmacists are required to document clinical interventions at their practice site during advanced pharmacy practice experiences (APPEs) with full-time and affiliate faculty. Interventions are documented in a single, commercially available, Web-based, password-protected system, Pharmacy One-Source/Quantifi (Pharmacy One Source, Bellevue, WA; www.pharmacyonesource.com). This system captures both hard and soft cost for interventions. All fourth year student pharmacists are trained on using the software and the process of documenting interventions prior to

the start of the APPEs. Full-time faculty members review the intervention process with the students at the beginning of each APPE. APPEs are 5 weeks in length with full-time faculty taking on average 12 students per year. Students have a 1-week break in July, a 2-week break in December/January, and a 4-week break between a class starting and finishing APPEs in April/May; thus, students are not on service all year long. Faculty members are traditionally in practice Monday through Friday most weeks of the year, except for 2 weeks during the December/January holiday break. Faculty members are expected to enter their interventions during months without APPE students. However, during months with students, full-time faculty members rely on students to enter the clinical interventions. Students may enter their interventions continuously during the APPE or prior to completing the APPE. The students' entry of interventions is verified by the full-time faculty member as part of the mid-point and final student evaluation, but individual interventions are not reviewed in detail. Affiliate faculty vary in the number of APPE students per year. The school's director of experiential learning verifies students' entry of interventions at the end of each APPE as affiliate faculty do not have access to the documentation system.

Reports of clinical interventions at APPE pediatric clinical practice sites (inpatient and outpatient) throughout the state of Alabama from 2011 to 2014 were collected. Practice sites in this study included one stand-alone pediatric hospital (380 beds), two women and children hospitals (150 beds and 198 beds), and one general pediatric clinic (1110 patient visits per month during the study period). The hospitals were all public, not-for profit, located in urban areas, and serve as academic teaching sites for schools of medicine, nursing, and pharmacy. Two full-time faculty members are employed by the school of pharmacy and practice at different pediatric sites in the state. One faculty member practiced in the PICU for all years of the study. The other faculty member practiced in the inpatient general pediatric setting then transitioned to an outpatient general pediatric clinic in July 2012 and stopped practicing in April 2014. Full-time faculty members practiced five half days a week at the clinical site, seeing patients with a medical team but did not have order entry or verification responsibilities. Both full-time faculty members' salaries are solely supported by the university. One faculty member completed a post-graduate year two residency in pediatrics, the other faculty member completed a pediatric fellowship, and both have been practicing for more than 15 years. Affiliate faculty preceptors practiced in the inpatient pediatric setting in various practice areas. All affiliate faculty members have affiliate appointments with the school of pharmacy and have varying training experience and years in practice. Affiliate faculty do not document interventions in the school's database system.

Pharmacy One Source provides cost avoidance data for the database system. These data are available for clients but not published publically. The calculation used for determining a potential cost avoidance is a conservative estimate. It takes into consideration the possibility of a preventable adverse drug event (ADE) occurring in combination with an average cost of a ADE reported in studies, as well as an estimated healthcare inflation rate factor. Based upon the calculations, most interventions are calculated at \$153 per intervention. Not all interventions are associated with a cost avoidance, such as medication reconciliation. Interventions that were a result of automatic conversion or protocols are not entered into the database system. Data were analyzed quantitatively and qualitatively in Microsoft Excel. All interventions were further classified as "activities" or "interventions." The "inpatient chart review/rounding," "outpatient chart review," "patient visit initial- 99605," and "patient visit reassess- 99606" interventions were classified as "activities" in this study as the faculty and student spend time on the activity/visit but a direct intervention in patient care may not occur. "Interventions" were defined as immediate changes or impact in patient care (e.g., drug therapy initiated or allergy information clarified). Using Microsoft Excel, the data were sorted based on the user (faculty or student), year, practice site, type of intervention and activity (e.g., inpatient chart review/rounding or patient counseling), number of activities and interventions, and associated estimated cost avoidance. This study received Institutional Review Board approval.

Results

Two full-time faculty members practice in pediatrics at the school of pharmacy and on average, 25 students training with full-time and affiliate faculty preceptors entered interventions at multiple pediatric practice sites each year. Data entered from a total of 100 students on 121 rotations were included in this study. A total of 12,784 interventions and activities were documented by faculty and students over the 4-year period, with students entering 81.8% ($n = 10,467$) (Table 1). During the study period, the average number of interventions and activities per a 5-week APPE entered by a student was 86. The average number of interventions and activities per faculty member over the study period was 1163. Sixty-nine percent of the interventions and activities occurred in the inpatient setting. Ninety-one percent of the student interventions and activities were documented on a full-time faculty member's clerkship. There were only six interventions documented that were not accepted by the physician.

The most frequent interventions for faculty and students were patient medication history, patient counseling-brief, clarification of allergy information, adjustment of drug therapy, and drug information-brief (Table 2). Specifically evaluating interventions documented by

Table 1. Annual Summary of Interventions and Estimated Cost Avoidance

Year	Student Activities and Interventions	Cost Avoidance	Faculty Activities and Interventions	Cost Avoidance	Total Interventions	Total Estimated Cost Avoidance
2011	2197 (n = 26)	\$272,188	1040 (n = 1)	\$126,356	3237	\$398,544
2012	2367 (n = 23)	\$328,266	736 (n = 2)	\$87,969	3103	\$416,235
2013	2970 (n = 24)	\$411,861	498 (n = 2)	\$66,764	3468	\$478,625
2014	2933 (n = 27)	\$387,320	43 (n = 1)	\$3885	2976	\$391,205
Totals	10,467	\$1,399,635	2317	\$284,974	12,784	\$1,684,609

faculty, medication reconciliation, antibiotic recommendations, and drug therapy consultations were the three most common interventions. Patient medication history, patient counseling-brief, and clarification of allergy information were the three most common student interventions. Intervention with less than 20 entries included: clarification of orders; adverse drug reaction (ADR) prevented; inpatient-anticoagulation consult/follow-up; over-the-counter (OTC) recommendation; drug interaction (disease/drug/food/lab); continuity of care; drug serum concentration avoided; evaluation of a chemotherapy regimen; evaluation of renal dosing; non-formulary medication processed; medication error; group patient education; avoidance of therapeutic duplication; initiate of deep vein thrombosis prophylaxis; prevention of an allergic reaction; inpatient-nutrition consult (non-total parenteral nutrition [TPN]); poison information; recommendation of therapeutic interchange; and patient's own medication evaluation.

Thirteen ADRs were prevented and four medication errors occurred reaching the patient yet fortunately no harm occurred. The most common cause of medication errors was prescribing. Individual medications corresponding with each ADR prevented and medication error were reviewed. Examples include acetaminophen, ketorolac, dantrolene, lansoprazole, nitric oxide, topiramate, furosemide, aspirin, ketoconazole, albuterol, enalapril, cefdinir, azithromycin, and polyethylene glycol. Two medications were antibiotics and two were classified as a pain medication.

When entering an intervention, there is an optional field to enter the name of the medication related to the intervention. Specific medications were cited in only 1928 interventions (15%). The most common medications listed were antibiotics: clindamycin (n = 120, 6.2%), vancomycin (n = 97, 5%), and amoxicillin (n = 90, 4.7%). Table 3 delineates the top 20 medications cited in interventions, which was 55% of the interventions with medications listed. Each medication was associated with a variety of interventions (e.g., antibiotic recommendations, drug therapy changes, patient counseling, etc.). Specifically, in evaluating only faculty interventions, the top three medications cited were vancomycin (n = 61), clindamycin (n = 49), and acetaminophen (n = 34). The top three medications cited in student interventions were prednisolone (n = 73), clindamycin (n =

71), and albuterol (n = 69).

The total cost avoidance for all 4 years was \$1,684,609 (Table 1). This equated to a potential cost avoidance of \$11,567 per student per APPE and \$142,487 per faculty member for the study period. The intervention with the highest estimated cost avoidance was patient medication history at \$108,171 (Table 2). Patient counseling-brief and clarification of allergy information were the next largest cost avoidances at \$54,621 and \$52,173, respectively. Antibiotic recommendations at \$42,800 and drug therapy consultation at \$26,163 completed the top five cost avoidances.

Discussion

Pharmacy practice faculty and student pharmacists documented a variety of interventions at different pediatric practice sites. This study is the first to describe an impact at multiple pediatric clinical practice sites, inpatient and outpatient and not within the same health-system, but throughout a state. In addition, this study evaluates the longest period of time published at this time, 4 years of interventions.

As students are required to document during APPEs in our school, we anticipated students to enter the majority of the interventions. The full-time faculty primarily practiced in the inpatient setting and all affiliate faculty rotations were conducted at inpatient facilities, thus the majority of interventions occurred in the inpatient setting. Condren et al¹⁰ found drug therapy change, pharmacokinetic monitoring, drug information, and medication histories/patient education to be the most common interventions for faculty and students in their 1-year period study. Combining our faculty and student data, this study found similar results with patient medication history, patient counseling, adjustment of drug therapy, and drug information being the top four out of five interventions.

The faculty primarily documented interventions related to medication reconciliation and drug therapy recommendations. However, they also initiated, discontinued, and adjusted drug therapy, as well as conducted pharmacokinetic consults or follow-ups and intravenous to oral (IV-to-PO) conversions. Students primarily document interventions related to the intake of patient information and patient counseling. These interventions aligned with daily practice activities of the faculty

Table 2. Details of Selected Interventions with Associated Cost Avoidance*

Intervention Type	Description of Intervention	Number of Interventions Total (Student/Faculty)	Cost Avoidance
Medication history	Gathering of a full medication history (including Rx, OTC, herbals, allergies) from patient, chart, other healthcare providers, and/or family members for documentation in a patient's medical or medication record.	707 (661/46)	\$108,171
Patient counseling-brief	Brief session to educate a patient (or their caregiver) on the patient's medication regimen, disease states, and/or non-pharmacologic therapy (5 min).	357 (344/13)	\$54,621
Allergy information clarified	Clarifying whether or not a patient has any allergies or if noted, the reaction to the listed agent.	341 (334/7)	\$52,173
Drug therapy adjusted (e.g., dose/frequency)	Optimization of a patient's medication regimen (e.g., changing dose, frequency, for an existing medication).	335 (238/97)	0
Drug Information-brief	Provision of drug information to a professional colleague (3 min).	300 (273/27)	0
Initiation of drug therapy	Initiation of a new medication or medication regimen	288 (199/89)	0
Medication reconciliation	Done with every transition of care in which new medications are ordered or existing orders are rewritten, i.e. when a patient is admitted to, transferred within, or discharged from a healthcare facility. Process of comparing medication orders by the physician to all of the medications that the patient has been taking (i.e., home medications). Includes a full medication history if needed.	210 (61/149)	0
Antibiotic recommendations	Recommending an initial regimen or making an adjustment to a current antimicrobial regimen (dose adjustments to antimicrobials should be documented under "drug therapy adjusted").	200 (79/121)	\$42,800
Vaccine recommendations	Recommending a vaccine be administered to a patient.	176 (174/2)	0
Drug therapy discontinued	Discontinuing an unnecessary medication.	175 (108/67)	0
Drug therapy consultation	Any consultation about a drug therapy ("curbside consult") outside a scheduled outpatient visit or inpatient encounter.	171 (56/115)	\$26,163
Core measure (Joint Commission) chart review	Chart review and evaluation of patient record for Joint Commission Core Measure criteria. Includes evaluation of home medications, review of lab values, and/or review of other studies or procedures. Core Measures to be reviewed include those being evaluated by the hospital for data collection and as appropriate to level of care.	102 (102/0)	0

IV-to-PO, intravenous to oral; OTC, over-the-counter; Rx, prescription; TPN, total parenteral nutrition.

* Interventions with more than 20 entries are reported in the table.

Table 2. Details of Selected Interventions with Associated Cost Avoidance* (*cont.*)

Intervention Type	Description of Intervention	Number of Interventions Total (Student/Faculty)	Cost Avoidance
Extended patient counseling	Extended session to educate a patient (or their caregiver) on the patient's medication regimen disease states, and/or non-pharmacologic therapy (15 min).	102 (77/25)	\$15,606
Inpatient -pharmacokinetic consult/follow-up	Consultation or follow-up for pharmacokinetics of any medication, including evaluating and ordering levels, adjusting medications, and writing notes, per prescriber's order.	86 (53/33)	\$13,158
IV-to-PO conversion	Convert a patient from IV to PO route for appropriate patient/medications.	83 (44/39)	\$1411
Extended drug information	Extended provision of drug information to a colleague (15 min).	75 (39 /36)	0
Evaluation of laboratory value	Evaluating a patient's laboratory or serum drug concentrations.	50 (49/1)	\$7650
Vaccination administered	Administration of a vaccine by a faculty member or student pharmacist.	46 (46/0)	0
IV drug compatibility	Answer compatibility question for prescriber or nurse.	26 (25/1)	\$3978
Lab/test ordered or conducted	Order or recommend ordering any diagnostic or monitoring test (e.g., serum, radiologic, questionnaires, point-of-care testing).	24 (23/1)	0
TPN evaluation/adjustment	Evaluating TPN and adjusting the order based on patient parameters.	22 (15/7)	\$3366

IV-to-PO, intravenous to oral; OTC, over-the-counter; Rx, prescription; TPN, total parenteral nutrition.

* Interventions with more than 20 entries are reported in the table.

and student pharmacists at the clinical practice sites. However, there were many high-level interventions by student pharmacists, such as initiating drug therapy and adjusting drug therapy (e.g., dose, frequency). Student pharmacists recommended and administered vaccines, as well as conducted Joint Commission Core Measures Chart reviews. Students conducted pharmacokinetics and anticoagulation consults and follow-ups. All of these interventions provided patient care and assisted the pharmacy department of the practice site. Institutions that have student pharmacists on APPEs should evaluate the interventions and activities that students are conducting and expand these when possible.

Only 13 ADRs were prevented and four medication errors were documented in the system. Additional ones likely occurred or were prevented but not documented. Students may have not been educated well on identifying and documenting the prevention of ADRs and medication errors. Faculty may have poorly documented these as well. The most common type of error was prescribing, which was similar to results from the Cunningham et al⁴ study focused on medication errors in a pediatric hospital. Our school needs to re-educate on documenting and identifying ADRs and medication errors in the pediatric setting.

When evaluating specific medications that were documented in the intervention, it is not surprising that antibiotics were the top three medications when combining faculty and student data. LaRochelle et al⁹ found this similar outcome as 34.4% of his interventions in the PICU were related to antibiotics. Antibiotics are commonly prescribed in the pediatric population and pharmacists frequently assist patient care with recommendations, monitoring, and counseling.

There are other benefits to documenting interventions besides cost avoidance. Faculty may use intervention data to justify their role, salary funding, and/or placement in a practice institution. Intervention data may also be used to develop outreach or service portfolios for faculty promotion. The documentation of activities and interventions can assist students in developing a practice portfolio to present at residency and job interviews. Students may also use the detailed data when describing APPE activities on their curricula vitae.

Limitations to the study include that all interventions and activities may not have been documented even though students were required to document on APPEs. Students and faculty may not have documented interventions that were not accepted by the physician/team even though these should have been documented and

Table 3. Top 20 Medications Cited in 1928 Interventions

Name of Medication	Number of Interventions (%)
Clindamycin	120 (6.2)
Vancomycin	97 (5)
Amoxicillin	90 (4.7)
Prednisolone	83 (4.3)
Albuterol	81 (4.2)
Ketorolac	66 (3.4)
Azithromycin	60 (3.1)
Acetaminophen	58 (3)
Amoxicillin and clavulanate potassium	56 (2.9)
Ceftriaxone	55 (2.8)
Ranitidine	38 (2)
Fluticasone	37 (1.9)
Hydrocodone and acetaminophen	33 (1.7)
Sulfamethoxazole and trimethoprim	32 (1.7)
Cefdinir	31 (1.6)
Insulin preparations	26 (1.3)
Lactobacillus	26 (1.3)
Budesonide and formoterol	24 (1.2)
Methylphenidate	24 (1.2)
Acyclovir	20 (1)

noted on the submission form that the intervention was not accepted. In this study, almost all interventions were accepted. The database default is marked to select accept; thus, students and faculty may not have changed this to the alternative. In addition, full-time faculty may not have documented personal interventions while students were on rotations with them, relying solely on the students to document all patient interventions. For the years 2011 and 2014, only one full-time faculty member entered interventions, thus potentially resulting in a lower number of interventions than actually occurred. This could be due to the faculty member having APPE students all year. All ADR preventions were not detailed in the database; thus, further information could not be provided. Specific disease states, medications, significance, and rate of acceptance were not consistently gathered in interventions. Although challenging to predict or determine, patient specific outcomes, such as improvement in health, absence from work/school, or decreased length of stay of these interventions, are unknown.

Disagreement may exist on the specific cost-avoidance values assigned to the activities and interventions by the database. A large number of interventions were classified as activities, defined as the review of a patient

chart or patient visit in the inpatient or outpatient setting. In this study, outpatient chart review had a cost avoidance due to built-in interventions accounting for medication history, lab evaluation, and patient counseling; when in actuality some may have not occurred. Several interventions in the database were not assigned a cost avoidance and potentially could increase the total estimated cost avoidance. For example, medication reconciliation, initiating deep vein thrombosis prophylaxis, therapeutic interchange, discontinuing drug therapy, and adjusting drug therapy have no associated cost avoidance in the current database. However, as practitioners we know these could impact costs for the institution. For example, Gardner et al⁸ determined that 89% of the medication reconciliation interventions at a children's hospital resulted in a change in therapy. These subsequent interventions and cost-avoidance estimates may not have been documented in our system. Although it would be challenging to nationally agree on the cost value of specific patient interventions, it would assist with providing a standard for associated costs. In addition, this database does not differentiate cost avoidance for an adult or pediatric patient or practice setting (inpatient, outpatient, intensive care unit, etc.), which likely varies in the healthcare system. Lastly, this study was conducted in multiple health systems throughout a single state within the United States. Its application to the healthcare system in the United States may not be extrapolated internationally.

Conclusions

Pharmacy faculty and students document various types of clinical interventions in the inpatient and outpatient pediatric setting. High-level interventions were documented by both faculty and students at the pediatric practice sites. The quality and quantity of interventions in this study support why faculty and students should be involved in the care of patients at pediatric practice sites. The documentation of clinical interventions by pharmacy school faculty and students demonstrate a positive impact at pediatric practice sites throughout a state, as well as contribute to cost avoidance of the healthcare systems. Pharmacy departments of health systems should allow students and associated faculty to document activities and interventions within their intervention documentation system or request the data if the faculty and students document within their own system. These data can assist in supporting the presence of faculty and students in clinical practice sites and positively impacting patient care. Additional economic data supporting these types of healthcare partnerships are needed.

ARTICLE INFORMATION

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