RESEARCH

Potential Cost Avoidance of Pharmacy Students' Patient Care Activities During Advanced Pharmacy Practice Experiences

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Objectives. To evaluate the potential cost avoidance of student interventions documented by fourth-year (P4) student pharmacists during advanced pharmacy practice experiences (APPEs) in outpatient and inpatient settings.

Methods. The school-wide Web-based intervention database was retrospectively analyzed to review characteristics of interventions documented during the 2011-2012 APPE cycle. Potential cost avoidance for interventions was derived from a comprehensive literature review and adjusted to 2011 dollars based on the consumer price index for medical care.

Results. Eighty-seven students (71% of the graduating class) documented 5,775 interventions over 36 weeks, with an estimated potential total cost avoidance of \$908,800. The intervention categories associated with the greatest cost avoidance were prevention of adverse drug events, provider education, and patient education.

Conclusions. Fourth-year student pharmacists and their preceptors had a positive impact, contributing to potential cost avoidance in both the inpatient and outpatient pharmacy settings.

Keywords: medication, cost avoidance, pharmacy interventions, student pharmacists, advanced pharmacy practice experience

INTRODUCTION

The Accreditation Council for Pharmacy Education mandates that student pharmacists in their fourth year of studies complete advanced pharmacy practice experiences (APPEs).¹ These experiences provide the opportunity for P4 students to obtain real-world training under the direct supervision of a pharmacist and to perform a variety of activities that may impact patient care by reducing medication errors and adverse drug events.² Additionally, students work collaboratively with other healthcare providers to optimize pharmacotherapy, counsel patients, and perform medication reconciliation and medication management services.

Medication error rates and estimations of resulting costs vary widely throughout the literature. Reported

error rates depend on several factors, such as healthcare setting, culture within a specific healthcare organization, differences in definition of medication error, patient population served, and variations in institutional reporting mechanisms.³ The Institute for Safe Medication Practice cautions that an institution with a high adverse event rate may have a better system for reporting and could actually be safer than an institution with a lower reported rate.³ Factors such as older patient age, female gender, and number of medications have been identified as increasing a patient's risk of having an adverse drug event (ADE) as an outpatient.⁴ According to the 2011 National Healthcare Disparities report, ambulatory care visits resulting from adverse effects of medical care are more likely to occur in female than male patients and in black patients than white patients.⁵

As of 2010, the mean length of a patient stay at a US community hospital was 4.7 days, with an average cost of \$10,079 per patient.⁶ Costs associated with admissions for complications from heart failure, diabetes, septicemia, thrombosis, or thromboembolisms are significantly higher.⁷ Adverse drug events could extend the length of stay for a patient in the hospital or lead to an increase in ambulatory care visits or hospital readmissions. Approximately 1.4%

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of hospital admissions were caused by an ADE, with an average cost of \$16,177 per ADE and \$10,375 per preventable ADE.⁸ Bates and colleagues estimated that 6.5 ADEs occurred per 100 non-obstetrical admissions, and of these, 42% of serious ADEs and 18% of significant ADEs were deemed to be preventable.⁹ Preventable adverse events have been associated with an increase in the hospital stay of approximately 4.6 days.¹⁰ Student pharmacists have the opportunity to suggest interventions to avoid medication errors and to reduce the occurrence of preventable ADEs and ultimately avoid a hospital admission, readmission, or decrease the length of stay and the associated costs.

While the actual and potential cost avoidance generated by pharmacists is well documented, the patient impact and cost avoidance generated by student pharmacists is not as well understood.^{11,12} An analysis of Northeastern University student interventions described student impact on patient care but did not estimate potential cost avoidance.¹³ The Auburn University Harrison School of Pharmacy reported the implementation of a Web-based documentation system to assess cost avoidance generated by pharmacy faculty members, students, and pharmacy residents.¹⁴ Campbell evaluated the cost avoidance generated by 15 student pharmacists at a psychiatric hospital.¹⁵ Other studies have focused on interventions in either inpatient or outpatient settings or had a limited number of student pharmacists' data.^{2,15-17} These studies were limited by the lack of adjustment of costs for inflation and may have, therefore, reported inaccurate potential cost avoidance.

In 2007, the Office of Experiential Education at the Northeastern University School of Pharmacy in collaboration with faculty members developed a school-wide intervention system integrated within the APPE management system, which has been previously described.¹³ In 2010, the former APPE management system was replaced by E-Value (Advanced Informatics, Minneapolis, MN) and the intervention system was adapted to the PxDx system available within E-Value software. In this study, faculty members aimed to analyze the interventions documented by P4 student pharmacists during the 2011-2012 academic year and to describe student impact on cost avoidance.

METHODS

The P4 year at the Northeastern University School of Pharmacy included six 6-week APPEs, 4 of which were required: ambulatory care, community practice, general medicine, and health system pharmacy practice experiences. The new Web-based E-Value intervention system contained fields to document patient demographics, drug-therapy problem category, description, drugs and disease

states involved, recommendations made, acceptance by the healthcare provider, economic impact, and preceptor involvement. For purposes of this study, an intervention was an actionable activity or recommendation that a student completed under the supervision of the preceptor. All student activities had the potential to be influenced by the preceptor; therefore, the cost avoidance impact reported in this study was attributed to the students and preceptors as a group.

During the initial group training in using the documentation system, students were instructed to document significant and meaningful interventions, resulting in an action or recommendation, rather than simply documenting all chart reviews, medication dispensing, etc. Students were also instructed in how to improve the consistency of their intervention documentation in PxDx. A handout summarizing documentation steps and definitions of terms was provided at the time of training and posted on the school's Blackboard site (Blackboard, Inc; Washington, DC) (Table 1). Additionally, the students as a group documented several interventions during the training to further improve consistency of documentation. During the APPE year, student documentation of interventions in the PxDx database was voluntary and depended on the type of practice experiences completed and preceptor requirements to avoid duplication of documentation efforts at sites that had their own intervention system. All preceptors were informed about the existence of PxDx and encouraged to require students to document their interventions and clinical services either in PxDx or in a site-specific database. Preceptors received the same training materials as the students and were instructed on how to review and sign off on student interventions. Preceptors had an option of approving the student intervention or asking for modifications of the intervention prior to approval.

To establish the potential cost avoidance associated with interventions, we conducted a literature search and reviewed data provided by Pharmacy OneSource for their Quantifi software (Pharmacy OneSource, Bellevue, WA). A search of PubMed between January 1990 to January 2013 was conducted with the terms "pharmacy student" and "cost avoidance" which yielded 6 articles, 2 of which were excluded because they focused on medication therapy management.^{2,14,15,17} References cited within the articles were also scanned to identify any other pertinent literature with a focus on publications within the last decade. The Quantifi algorithm provided a conservative estimation of cost avoidance for ADEs by accounting for the likelihood of a preventable ADE occurring in combination with an estimated healthcare inflation rate factor that adjusted for the average cost of ADEs reported in the literature.

Table 1. Definitions of Economic and Clinical Impact of Pharmacy Students' Interventions During Advanced Pharmacy Practice Experiences

Type of Impact ^a		Interventions, No. (%)
Economic	“...any preventable event that may cause or lead to inappropriate medication use or patient harm, while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems including: prescribing; order communication; product labeling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use.” ²¹	1,971 (34.1)
Prevented medication error		
Prevented adverse drug event	“an injury resulting from the use of a drug. Under this definition the term ADE includes harm caused by the drug (adverse drug reactions and overdoses) and harm from the use of the drug (including dose reductions and discontinuations of drug therapy).” ²¹	2,082 (36.1)
Long-term cost impact	cost savings in not anticipated during this hospital admission or visit but are expected in the future due to decrease in morbidity and mortality	4,120 (71.5)
Immediate cost impact	cost savings is anticipated during this hospital admission or immediately	1,890 (32.7)
No cost impact	Provided drug information	484 (8.4)
Clinical		
No significance	Recommendation is informational	423 (7.3)
Somewhat significant	Benefit to the patient could be slightly beneficial (e.g. patient education or recommendation for a more appropriate dosage form)	758 (13.1)
Significant recommendation	Brought care to a more acceptable and appropriate level (e.g. any interventions that add therapy to ensure that standard of care is met or dosing the medications appropriately to reach therapeutic goals and avoid toxicity)	3,869 (67.0)
Very significant	Potentially serious immediate consequences to patient without recommendation (e.g. discontinued contraindicated drug or avoided a medication that a patient is allergic to)	669 (11.6)

^a Students could select all the cost impacts that applied.

Identified costs were adjusted for inflation to December 2011 US dollars using the consumer price index for medical care.⁴ This month was chosen because it was approximately the midpoint of the academic year in which interventions were reported. The costs were derived from similar intervention categories described in previously published articles.¹⁶⁻¹⁸ When multiple sources were identified for a specific category, inflated costs were averaged. Final costs used in the analyses are presented in Table 2. In cases when the published literature did not indicate the year the dollar amounts were calculated, the date of publication became a conservative strategy for estimating costs for this analysis. For purposes of this study, we included both immediate (eg, discontinuation of a medication) and long-term costs (eg, addition of a medication to

bring care to the standard and avoid future morbidity and mortality) when calculating cost avoidance. To explore the uncertainty associated with the estimates used, we conducted sensitivity analyses using the following scenarios: (1) low and high dollar values reported in the literature for interventions where a range was available; (2) zero dollars of cost avoidance assigned to “provider education”; and (3) cost avoidance if zero ADEs were prevented. The latter 2 scenarios were chosen because these intervention categories were associated with the highest cost savings estimates.

All interventions entered into the E-Value PxDx system between May 1, 2011, and May 1, 2012, a full academic year, were analyzed. We used descriptive statistics to analyze common intervention categories, percent of

Table 2. Estimated Potential Cost Avoidance per Intervention Category

Category	Definition	US Dollars ^a	Range of Estimates (US Dollars)
Addition of medication ^{16,17}	Addition of a medication for a clinical indication when a drug is not used to bring the level of care up to the standard	244.96	87.96-401.96
ADE prevention ^b	Any intervention that potentially avoids an adverse drug event, such as appropriate dose adjustments for renal or liver dysfunction, management of drug interactions, or avoiding a medication when contraindications are present	191.08	
Discontinuation of medication ²¹	Discontinuation of a medications when therapeutic duplication or no indication is present	95.97	93.51- 98.43
Dose adjustment therapeutic ¹⁶	Increases in dose to obtain appropriate therapeutic efficacy and/or achieve desired therapeutic goal	79.32	
Drug information to patient ¹⁷	Brief encounter with a patient where a particular question is answered	57.71	
Non-formulary conversion ¹⁸	Switch to an appropriate therapeutic equivalent available on a formulary (either hospital, insurance, or pharmacy generic preferred list)	88.59	
Patient education ¹⁶	A comprehensive consultation with a patient that focuses on disease state management and medication and adherence counseling	97.86	
Provider education ¹⁷	Formal and informal education including interactions during patient care activities and in-services	382.54	

^a Inflated to December 2011 US\$ using the consumer price index (CPI) for medical care.

^b Adopted from Quantifi software (Pharmacy OneSource, Bellevue, WA).

interventions accepted by providers, and student perceived clinical impact. Cost avoidance was estimated by multiplying the number of interventions in a particular category by the cost avoidance per intervention. Intervention categorization and the potential avoidance of ADEs were contained in different fields of the database; therefore the interventions within some of the categories were divided into 2 groups based on whether they resulted in ADE prevention to avoid double-counting. This study was approved by the Northeastern University Institutional Review Board.

RESULTS

There were 125 unique practice experience sites offered during the 2011-2012 academic year for a total of 735 placements for 123 students, 1 of whom began the APPE year late and did not complete all 6 APPEs during this academic year. Students completed a combined 327 hospital, 134 community, and 124 ambulatory care APPE experiences, with the balance of experiences (n=150) being in non-patient-care environments.

Eighty-seven students (71%) documented 5,775 interventions at 34 unique APPE sites over 36 weeks in 577 placements. Of the 34 unique sites, 23 (67.6%) were

within the Boston area, 6 (17.6%) were within 25 miles of the Boston area, and 5 (14.7%) were either >25 miles from the Boston area or located out of state. There were 43 preceptors who supervised students with documented interventions. Of these, 21 were clinical faculty members and 22 were adjunct preceptors; faculty-precepted students documented significantly more interventions (91.4% of all interventions, average of 251.5 interventions per preceptor), compared with students who had adjunct preceptors (8.6% of all interventions, average 22.6 interventions per preceptor).

Students documented 5775 interventions (66.4 interventions per student over 36 weeks of APPEs; range 1-453). Of these, 2,557 (44.3%) were documented in the ambulatory care setting, 200 (3.5%) in the community setting, and 2,998 (51.9%) in the inpatient hospital setting. Students provided age and gender of the patients for 55% of interventions documented and race/ethnicity for 40% of interventions documented. Of those patients for whom information was available, 46.3% were women, 43.4% were geriatric patients (65 years and older), 18.7% were African American, 6% were Asian, 57.7% were Caucasian, and 16.9% were Hispanic.

The most common categories of interventions across all 3 settings were patient education (n=1520, 26.3%), health provider education (n=913, 15.8%), drug information to patients (n=581, 10.1%), health promotion and disease prevention (n=523, 9.1%), and therapeutic dose adjustment (n=405, 7%). Some variation in the top 5 intervention categories occurred in each setting (Table 3). Diabetes and hypertension were the most common disease states for which interventions were conducted across all settings.

Students identified 88% of all interventions as having some degree of clinical impact (Table 1). Only 3% of the interventions that involved a change in medications were rejected by the patient's prescriber, while 71% were accepted by the prescriber; the remaining 26% of interventions were informational in nature (did not involve a prescriber). Students spent the least amount of time on interventions conducted in the community setting, with 80% of these interventions taking 15 minutes or less. In the inpatient hospital setting, students expended 15 minutes or less on 60% of all interventions, 16 to 30 minutes on 25%, and 30 to 60 minutes on 14%. Interventions conducted in the ambulatory care setting required the most student time per intervention, with 38% of interventions taking 15 minutes or less, 36% taking 16 to 30 minutes, and 23% taking 30 to 60 minutes.

We estimated the potential cost avoidance for 4,741 (82%) of the interventions based on published cost avoidance data for various types of interventions.^{16-18, 20} There were no cost estimates available in the literature for the remaining 18% of interventions; therefore, they were excluded from cost analyses. The estimate of total cost savings was \$908,800 (2011 US dollars) when we accounted for interventions that prevented an ADE regardless of intervention type (Table 4). Provider education, addition of medication, patient education, and ADE prevention accounted for the majority of cost avoidance. The 3 sensitivity analysis scenarios yielded cost avoidance estimates from \$559,543 to \$962,928. When high and low values for categories "addition of medication" and "discontinuation

of medication" were used, estimated cost avoidance was \$854,670 to \$962,928. Assigning zero dollars to "provider education" yielded a total estimated cost avoidance of \$559,543. When cost avoidance assigned to prevention of ADEs was eliminated, the final cost avoidance estimate was \$667,519.

DISCUSSION

Student pharmacists working under the supervision of their preceptors in various APPE settings had a positive impact on cost avoidance over the course of 1 academic year. We found a potential cost avoidance of \$10,445 per student and an average of 66.4 interventions per student (across all practice experiences) compared to Stevenson and colleagues, who found \$7,507 cost avoidance and 200 interventions per student in 2010. They reported that the average cost avoidance per student increased from \$2,721 in 2007 to \$7,507 in 2010, while the average number of interventions/activities per student pharmacist increased from 92 to 200 over the same 4-year span. The most frequently recorded interventions were inpatient encounters consisting of rounding, chart review, patient counseling, and drug therapy adjustment. The interventions with the most potential cost avoidance were patient counseling, laboratory evaluation, and antibiotic recommendations. While the average number of interventions reported per student in our study was lower than that in Stevenson's study, the estimated cost avoidance was higher. A possible explanation is that we were able to assign cost avoidance to a larger percent of the interventions. Mersfielder reported a range of 1.2 to 6.2 interventions per student per week in their literature review, which is consistent with our findings of an average of 1.8 interventions per student per week.² Campbell evaluated 15 students completing practice experiences at 1 psychiatric hospital and found cost savings were \$404 to \$1,535 per student over the course of their practice experience.¹⁵ Of the 320 interventions in this study documented over the 8-month period of the practice experience year, the most common categories were patient

Table 3. Five Most Common Drug-Therapy Problem Categories by Setting

Ambulatory Care (N=2557)		Community (N=200)		Hospital Inpatient (N=2998)	
Category	No. (%)	Category	No. (%)	Category	No. (%)
Patient education	913 (35.7)	Patient education	45 (22.5)	Provider education	733 (24.4)
Health promotion and disease prevention	377 (14.7)	Health promotion and disease prevention	39 (19.5)	Patient education	562 (18.7)
Drug info to patient	328 (12.8)	Drug info to patient	35 (17.5)	Dose adjustment	236 (7.9)
Provider education	171 (6.7)	Addition of medication	14 (7)	Addition of medication	220 (7.3)
Dose adjustment	167 (6.5)	Adverse drug event	14 (7)	Drug info to patient	218 (7.3)

Table 4. Potential Cost Avoidance^a

Intervention Category	N	ADE Prevention	No.	2011/2012 \$	Total \$
Addition of medication	344	No		244.96	84,267
Discontinuation of medication	110	No	49	95.97	4,703
		Yes	61	191.08	11,656
Dose adjustment therapeutic	405	No	295	79.32	23,400
		Yes	110	191.08	21,019
Drug information to patient	581	No	358	57.71	20,660
		Yes	223	191.08	42,611
Non-formulary conversion	102	No		88.59	9,036
Patient education	1,520	No	1,015	97.86	99,328
		Yes	505	191.08	96,496
Provider education	913	No		382.54	349,257
All other categories	766	Yes		191.08	146,367
Total	1,679				908,800

Abbreviations: ADE=adverse drug event.

^a Cost avoidance estimates reflect base case analysis (ie, prior to sensitivity analyses).

education (13.1%), order clarification (11.6%), and dose adjustment (10.9%). Previous studies did not adjust for inflation when estimating costs, whereas our study did, and therefore provides a more accurate representation of potential cost avoidance during the time that interventions were completed.

We compared our intervention data from the PxDx system with previously reported data using the earlier intervention system.¹³ Provider education in the inpatient setting had increased from 10% to 24%, while patient education remained about the same in the ambulatory care setting, from 38.1% to 35.7%, and decreased from 31.8% to 22.5% in the community setting.¹³ The self-identified perception of clinical impact was similar between the 2 datasets. Documentation rates also remained steady with 5,775 interventions documented in 1 year in PxDx compared with 15,393 interventions over a 3-year period in the previous dataset. With regard to the potential for clinical impact in the new system vs. the old system, we found the following: 7.4% vs 9.6% of all interventions were not significant, 13.7% vs 20.3% were somewhat significant, 67.7% vs 53.4% were significant, 11.7% vs 15.3% very significant, and 1% vs 1.4% were undocumented. The proportion of interventions that prevented an ADE were also similar (36% in the new system vs 29% in the old system).¹³ Overall, we found that the documentation rates and intervention characteristics were similar between the old and new intervention systems.

Our study had several limitations. Students rather than faculty members or preceptors determined how to categorize each intervention, including its potential economic and clinical outcome. We relied on preceptors to review, validate, and accept the student recommendations, and no independent validation of documented

interventions occurred. Although students were trained to document interventions and had received formative feedback during simulated laboratory and seminar exercises as part of that training, we also provided group training on proper documentation in PxDx to improve consistency. However, some variation probably occurred in how interventions were categorized. There is also the potential for social desirability bias to occur when documenting interventions. Students and preceptors may be more likely to overestimate the impact and significance of the interventions in order to feel competent or needed. A potential future area of research may be a review of inter-rater reliability of how students document the same interventions as well as how interventions are reviewed by different preceptors.

Because of the voluntary nature of intervention reporting, this study probably underreported actual student interventions. Some preceptors required that students enter interventions into the system whereas other preceptors may have left it optional. Students were also more likely to underreport interventions that were not accepted by the providers because of the social desirability bias. The large number of interventions (91.4%) that were derived from full-time faculty-precepted practice experiences might be explained by several factors. Full-time faculty members were motivated to document their clinical services and therefore required students to use the PxDx intervention database. Further, they may have lacked access to hospital-specific intervention databases, unlike the adjunct faculty preceptors. Additionally, full-time faculty members may have been more informed regarding the availability of PxDx. There were also low documentation rates during community practice experiences, which represented 18% of all placements and which were

all precepted by adjunct faculty members. The low documentation rates in this setting can be explained by the Internet access restrictions and the fast-paced environment of these sites.

We relied on published cost estimates for the interventions performed by pharmacists and pharmacy students; however, cost estimates were not available for all of the interventions reported in our database. Also, by accepting the published cost estimates as accurate, we did not address how they were derived and, therefore, carried forward any inaccuracies into our analysis. Additionally, the analysis did not include the cost of the faculty members' time or cost of resources devoted to training student pharmacists as these would be challenging to estimate and such estimates had not been made in similar studies reported in the literature. Our cost avoidance included both immediate and long-term costs and therefore represented the overall impact (immediate and future) that students and preceptors would have on health care costs rather than on immediate cost savings to a patient or practice site.

A review article that discussed the value of student pharmacists to the practice site found only 29 published studies and 6 abstracts between 1990 and 2011.² Given that almost 12,000 student pharmacists graduated in 2011, we estimated the potential cost savings achieved by student pharmacists at \$84 million per year.¹⁹ Other schools of pharmacy should consider performing similar analyses of student interventions to further validate these data on a national level. Additionally, establishing best practices for the documentation of clinical services by pharmacy students will help educators prepare them for the realities of practice and the importance of documentation.

Medicare does not currently recognize pharmacists as healthcare providers even though progress occurred in 2003 with payment for medication therapy management. Pharmacists will be playing greater roles in patient-centered medical homes and accountable care organizations as the Affordable Care Act is implemented in the years ahead.²⁰ Pharmacists and student pharmacists should be more effectively used to meet the needs of the healthcare system while reducing unnecessary costs.

CONCLUSION

Fourth-year student pharmacists and their preceptors positively impacted patient care during their APPEs by providing patient and provider education, dose adjustments, health promotion, and disease prevention services, and significantly reduced health care costs. The estimated cost avoidance generated during one APPE cycle was

\$908,800. More investigation is warranted to better understand how student pharmacists are used in patient care settings as the Affordable Care Act is implemented.

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