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Abstract

Objectives: *To assess the baseline knowledge of fourth year student pharmacists on their ability to properly identify and categorize medication related problems (MRP) during their Advanced Pharmacy Practice Experience (APPE) in the ambulatory care setting, and to assess the efficacy of a written resource designed to educate and train users on identification and documentation of MRP's and used for this purpose with participating students on their ambulatory care APPE.*

Methods: *A pretest consisting of ten multiple-choice questions was administered electronically to fourth year student pharmacists (N=18) at the start of their ambulatory care APPE. The test was designed to assess both the students' baseline knowledge regarding MRP's, and their ability to identify a wide variety of medication-related problems. Students then received a written copy of The Medication Therapy Intervention & Safety Documentation Program training manual and were asked to read it in its entirety in the first week of their APPE. Finally, students were given a posttest survey (identical to the pretest) to complete to assess if their knowledge had increased from baseline.*

Results: *The average score for the 18 students taking the baseline knowledge pre-test was 63.33%, indicating limited baseline knowledge regarding the identification and classification of MRP's. In assessing the effectiveness of the written training document, the overall posttest results compared to pretest results did not indicate improvement in students' knowledge or ability to properly identify and classify medication related problems (MRP) after reviewing the training manual. The average scores declined from 63.33% on the pretest to 62.78% on the posttest, although this was not found to be statistically significant (p = 0.884). However, a statistically significant decline in students' knowledge occurred on one specific question, which tested their ability to classify MRP's (p = 0.029).*

Conclusions: *Based on the results of the pre-test, students at our institution enter their APPE year with limited baseline knowledge of medication safety within the ambulatory care setting. Results from the posttest indicate potential ineffectiveness of a written document in providing effective education on MRP's to students in the experiential setting. Education may be made more effective with a hands-on, active learning approach that overcomes the limitations of other passive forms of learning.*

Introduction

In November 1999, the Institute of Medicine (IOM) released its landmark report, *To Err is Human: Building a Safer Health System,* which discussed the dire need to address medical errors within the United States healthcare system. The report estimated up to 98,000 deaths occur annually due to preventable medical errors.[1] These unfortunate incidents in turn cost approximately $29 billion in both profits lost and augmented health care costs. [1] Since the release of the report, there have been many other reports and research addressing the morbidity and mortality rates of patients in the United States due to medication errors. [2,3] However, it has only been within the last decade that the focus on patient safety has begun to shift from almost exclusively inpatient care to include the outpatient arena. The Agency for the Healthcare Research and Quality (AHRQ), specifically addressed this issue stating, "medical error and injury are substantial in ambulatory care, but there has been little systematic research specifically aimed at patient safety questions in ambulatory care." [4]

Of the 98,000 deaths that were estimated to occur annually by the IOM report, about 7,000 of them can be directly associated to a medication related problem (MRP) such as

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medication errors, adverse drug events, or adverse drug reactions.[1] The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines a medication error as any preventable event that may cause, or inevitably lead to, harm to the patient.[5] Only an estimated 1% of medication errors cause patient harm, as some either do not reach the patient, or reach the patient but don't have a clinical impact.[6] However, a medication error could result in either an adverse drug event (ADE), which is described as an injury from the use of a drug (at normal doses or from an overdose), or an adverse drug reaction (ADR), characterized as an unintended response to a drug at normal doses or during proper use.[6] Not all ADE's and ADR's are related to medication errors; however, it is estimated that 25% of all ADE's and ADR's can be directly linked to a medication error, meaning that for every four patients harmed by a medication, one of the incidents could have been prevented.[6]

Research has shown that MRP's can be reduced through the implementation of medication safety programs.[7] In order to ensure successful implementation of these programs, it is imperative that pharmacists are involved.[8-11] The American Society of Health-System Pharmacists (ASHP) endorses this concept, stating that "medication safety is the fundamental responsibility of all members of pharmacy."[10] ASHP goes on to say that, "because of their training, abilities, and knowledge of the medication-use process, pharmacists are uniquely qualified to fill the roles and meet the responsibilities as a pertinent team member regarding medication safety in health systems."[10] The Institute for Safe Medication Practices (ISMP) also supports the utilization of pharmacists in relation to medication safety. In their two part series entitled *Medication Errors: A Year in Review,* they state, "the prevention of medication errors is an essential component of pharmaceutical care and must be a core mission of every pharmacy."[11]

Understanding the importance of medication safety, ASHP has encouraged schools of pharmacy and residency programs throughout the nation to incorporate an increased amount of medication safety training in their respective programs.[12] Furthermore, the Accreditation Council for Pharmacy Education (ACPE) suggested schools of pharmacy should consider integrating more patient safety training and increasing their advancements on measuring, reporting, and improving the quality of pharmacy practice to reduce the medication-related problems.[13] In their 2011 update, the Accreditation Council for Pharmacy Education (ACPE) identified several factors for this focus, which included reports from the Institute of Medicine (IOM) that described the changes needed in the United States healthcare system.[13] The IOM noted the following five competencies that all healthcare professionals should attain during their education to improve medication safety and patient outcomes: provide patient-centered care, work in interprofessional teams, employ evidence-based practice, apply quality improvement, and utilize informatics.[14]

Existing pharmacy education literature indicates that the education students receive on medication safety typically exists in the didactic classroom, without the incorporation of a skill-oriented environment such as a laboratory or inpatient/outpatient experience.[15,16] There are, however, a few exceptions. One institution in particular, Purdue University, sought to create a laboratory setting experience in which students were involved in identifying medication errors.[17] Specifically, students were introduced to the medication related problems nomenclature, including adverse drug reactions, adverse drug events, and medication errors. Within the training session, the pharmacy students were then tested on their knowledge regarding MRPs with a pre/posttest examination. The results from the assessments showed a 66.9% improvement from the pretest to posttest, and ultimately indicated the advantages of education with regards to identifying MRPs.

While some information exists on medication safety education in the didactic curricula, little information exists on this type of education in the APPE setting. ASHP states that "students often enter experiential rotations with limited knowledge about medication error prevention, a safety culture, or how to apply generally accepted safe practices".[12] In their policy positions on education and training, ASHP notes that medication safety is so important that students should receive education on the topic throughout didactic courses as well as experiential education, and encourages experiential preceptors to help students identify potential areas for improvement within the system.[12]

The purpose of this study was to assess fourth year pharmacy students on their knowledge of and ability to properly identify and categorize medication related problems (MRP) during their Advanced Pharmacy Practice Experience (APPE) in the ambulatory care setting, and to assess the efficacy of a written resource designed to educate and train users on identification and documentation of MRP's and used for this purpose with participating students on their ambulatory care APPE.

Methods

To effectively evaluate their baseline knowledge on MRP's, fourth year pharmacy students were given an identical pretest and posttest while on their ambulatory care rotation at the Jefferson County Department of Health in Birmingham, Alabama. The test was created by the primary investigator,

who also served as one of the two faculty experiential preceptors for the site. The tests consisted of ten multiple-choice questions, which covered three key components with regards to patient and medication safety and were based off of the training document that the students received upon completion of the pretest. Firstly, the survey was designed to challenge the students' ability to distinguish between potential adverse drug events (pADE), adverse drug events (ADE), and medication errors (ME). Secondly, the questions tested the students' ability to categorize medication related problems (MRPs), determining whether or not an ADE or ME occurred, and rating the severity of patient harm according the *NCC MERP Index for Categorizing Medication Errors*. Finally, the survey questions tested the students' ability to categorize the MRP according the suspected root problem of the patient case.

The pretest survey was emailed to students at the start of their ambulatory care APPE in the form of a Google Docs link, and the results were recorded for the preceptors to evaluate. After completion of the pretest, students received a written copy of the *Medication Therapy Intervention & Safety Documentation Program* training manual via email and were instructed to read the contents in its entirety during the first week of their APPE. The *Medication Therapy Intervention & Safety Documentation Program* is the system utilized to document MRP's at the Jefferson County Department of Health by pharmacy preceptors, residents, and students on their APPE, and was developed by Dr. Steve Chen. This documentation system has also been used by the Health Resources and Services Administration (HRSA) Patient Safety and Clinical Pharmacy Services Collaborative (PSPC) as the primary documentation tool for medication-related problems including medication safety issues, and both the form and the training manual are available electronically.[18,19]

The manual itself sought to provide background information related to identifying, categorizing, and reporting medication-related problems in the realm of pharmacy practice. In addition, the manual also offered insight in defining pADEs, ADEs, and ME, and explained how to properly input this data into a program. After reading the training manual, the students were emailed the link to the Google Docs posttest survey (identical to the pretest survey) and instructed to complete the questions with their newfound knowledge and training with regards to medication and patient safety. Results from the posttest survey were then collected and reviewed by the faculty preceptors to ensure completion. Students received credit for completing the assignment as part of their grade for the APPE, but the credit was not performance based.

Results

There was a 100% response rate from the 18 students, who completed both the pretest and posttest multiple-choice question survey. Data analysis was assisted by Minitab, release 162.2.2 software. A paired t-test with a repeated measures design was performed to assess for increases in the students' knowledge regarding patient safety and for classifying MRPs as measured by the identical pretest and posttest instrument. Table 1 depicts the results from each question, along with the total score for the pretest and posttest instrument. Out of a perfect score of 10, the mean pretest was found to be 6.333 (63.33%). In addition, the standard deviation and standard error of the mean with pretest was 1.320 and 0.311 respectively. The mean score of the posttest was found to be 6.278 (62.78%), while the standard deviation and standard error of the mean was 1.320 and 0.311 respectively. The mean difference between the pretest and posttest was not found to be statistically significant. However, there was a statistical significance observed in question 9 of the survey, which tested the student's knowledge on classifying MRPs using a modified *NCC MERP Index for Categorizing Medication Errors* guide. A decline in student knowledge was observed in this question from pretest to posttest (95% CI for mean difference: (0.038, 0.629), p-value=0.029).

Discussion

Initial results from the pretest indicate a limited knowledge base on MRP's for students from the study institution, and have prompted discussion amongst faculty on where in the curriculum additional content on medication safety can be included. While extrapolation of data for the pretest results will be limited due to it being content-specific for a single school of pharmacy, it does indicate a potential need for all institutions to assess student knowledge and performance in this area to ensure that they are receiving a sufficient amount of exposure to content on medication safety in the didactic curriculum that they can apply in the experiential setting. While students' answers improved on five of the ten questions, the data analysis did not indicate an increase in overall student knowledge with regards to patient and medication safety with the use of a pre and post intervention method. More importantly, the total mean scores from the pretest to the posttest actually declined with the incorporation of the patient safety and training orientation document provided before the posttest. This result may potentially indicate that the written training document was ineffective in teaching students how to explain, categorize, and distinguish between MRPs. The lack of improvement in student knowledge may demonstrate that an educational method utilizing more of an active learning approach may be more effective in allowing students to apply and retain

content related to medication safety, particularly in the experiential setting.

One limitation observed in this study was the small sample size (N=18), which increased the difficulty in detecting small changes in pretest and posttest scores. A larger sample size could potentially be obtained by incorporating students from a variety of ambulatory care APPE practice sites, as a single site has a limited capacity for students over the course of a year. Additionally, there would be benefit to comparing the written educational method to an active learning method between separate student groups- however, this again would require a larger sample size and would need coordination between preceptors at multiple practice sites.

One way that the results have changed the medication safety training that students receive at the study practice site is that rather than being trained only by using the written document, students now also participate in a group discussion regarding MRP's identified in the previous month at the practice. Students have the ability to observe how the MRP's were identified, classified, and categorized, and to ask questions during the discussion for clarification or additional information. While the efficacy of this method has not yet been formally evaluated, anecdotal observation of the two preceptors indicates that students have shown an increased interest and engagement in the documentation of MRP's following the group discussion.

Conclusion

Education in the didactic pharmacy curriculum on medication safety is encouraged by many national organizations, but may be inadequate at some institutions. Furthermore, there is little published literature regarding education on medication safety in the APPE setting. Based on the results of the pre-test, students at our institution enter their APPE year with limited baseline knowledge of medication safety within the ambulatory care setting. Additionally, the results of the post-test within this sample of students suggest that utilization of a written document on MRP's is not an effective educational method. Rather, training students on medication safety within the experiential setting may be made more effective with a hands-on, active learning approach that overcomes the limitations of other passive forms of learning. Regardless, great care must be taken to ensure that the key fundamentals of medication use and patient safety are well understood by fourth year pharmacy students to improve their expertise and clinical knowledge during the Advanced Pharmacy Practice Experience (APPE) and for use as future practicing pharmacists.

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Table 1.

	PRETEST MEAN(SD)	POSTTEST MEAN (SD)
Q1	0.889 (0.323)	0.778 (0.428)
Q2	0.8333 (0.3835)	0.9444(0.2357)
Q3	0.8889 (0.3234)	1.0000 (0.000)
Q4	0.222 (0.428)	0.111 (0.323)
Q5	0.333 (0.485)	0.278 (0.461)
Q6	0.9444 (0.2357)	1.000 (0.0000)
Q7	0.8333 (0.3835)	0.9444(0.2357)
Q8	0.278 (0.461)	0.444 (0.511)
Q9a	0.556 (0.511)	0.222 (0.428)
Q10	0.556 (0.511)	0.000 (0.594)
TOTAL SCORE PRETESTb	6.333 (1.283)	
TOTAL SCORE POSTTESTb		6.278 (1.320)

a. 95% CI for mean difference: (0.038, 0.629), p-value = 0.029

b. 95% CI for mean difference: (-0.735, 0.846), p-value = 0.884

Appendix 1. Patient Safety Pretest/Posttest Survey

1. Which of the following would best be described as an event which caused harm by a drug or the inappropriate use of a drug?
A. Potential Adverse Drug Event (pADE)
B. Adverse Drug Event (ADE)
C. Adverse Drug Reaction (ADR)
D. Medication Error (ME)

2. Which of the following would best be described as circumstances that could result in harm by the use of a drug but did not harm or reach the patient?
A. Potential Adverse Drug Event (pADE)
B. Adverse Drug Event (ADE)
C. Adverse Drug Reaction (ADR)
D. Medication Error (ME)

3. Which of the following would best be described as harm caused by a drug at a normal dose and during normal use?
A. Potential Adverse Drug Event (pADE)
B. Adverse Drug Event (ADE)
C. Adverse Drug Reaction (ADR)
D. Medication Error (ME)

4. Newly diagnosed obese adult Type 2 DM patient NOT receiving metformin. Classify the medication-related problem.
A. Appropriateness/Effectiveness : Untreated medical problem
B. Safety: Incomplete / improper directions
C. Appropriateness/Effectiveness : Treatment not optimal based on current evidence / guidelines
D. Safety: No indication for medication prescribed

5. Medical record indicates that patient should be taking metformin 500mg BID, but pt is taking metformin 500mg daily and A1C consistently below 7%. Classify the medication-related problem.
A. Appropriateness/Effectiveness : Drug dosing not adequate for treatment goals
B. Safety: Drug dosing excessive for treatment goals
C. Non-adherence/Patient Variable: Medication underuse / poor adherence
D. Miscellaneous: Other

6. Diabetes patient commonly forgets to take dose of Byetta before dinner and A1C is 7.3% Classify the medication-related problem .
A. Appropriateness/Effectiveness : Treatment not optimal based on current evidence / guidelines
B. Safety: No indication for medication prescribed
C. Non-adherence/Patient Variable: Medication underuse / poor adherence
D. Safety: Adverse drug reaction (ADR)

7. Patient prescribed a penicillin antibiotic even though listed penicillin allergy; patient bought and took medication and developed hives. Benadryl required to resolve hives. Classify the medication related problem according to the modified NCC MERP Classification Index.
A. Classification C: Med error/event reached patient, but no harm
B. Classification D: Med error/event reached patient, monitoring or intervention required to confirm no harm
C. Classification E: Event occurred, resulting in temporary harm and requiring intervention
D. Classification F: Event occurred, resulting in temporary harm and requiring hospitalization

8. Patient discontinues blood pressure medication due to cost. Blood pressure becomes elevated; however the patient is asymptomatic and all labs are within normal limits. Classify the medication related problem according to the modified NCC MERP Classification Index.

A. Classification A: No med error / event, but potential for ADE identified
B. Classification B: Med error/event DID NOT reach patient
C. Classification C: Med error/event reached patient, but no harm
D. Classification D: Med error/event reached patient, monitoring or intervention required to confirm no harm

9. Patient experiences severe hypoglycemia from insulin secondary to skipping breakfast. Patient required transport to hospital and IV dextrose infusion before regaining consciousness. Classify the medication related problem according to the modified NCC MERP Classification Index.
A. Classification F: Event occurred, resulting in temporary harm and requiring hospitalization
B. Classification G: Event occurred, resulted in permanent harm / disability
C. Classification H: Event occurred, life-threatening
D. Classification I: Event occurred, resulted in death

10. Metformin dispensed with a label reading, "Take by mouth twice daily with dinner". At next visit, patient asks you if he/she has taken his/her metformin correctly. When questioned, patient states he/she took one tablet with breakfast and dinner. Classify the medication related problem according to the modified NCC MERP Classification Index.
A. Classification A: No med error / event, but potential for ADE identified
B. Classification B: Med error/event DID NOT reach patient
C. Classification C: Med error/event reached patient, but no harm
D. Classification D: Med error/event reached patient, monitoring or intervention required to confirm no harm

Answer Key: 1-B, 2-A, 3-C, 4-A, 5-B, 6-C, 7-C, 8-C, 9-C, 10-C