RESEARCH ARTICLES

Medication Error Identification Rates by Pharmacy, Medical, and Nursing Students

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Objective. To assess and compare prescribing error-identification rates by health professional students. **Methods.** Medical, pharmacy, and nursing students were asked to complete a questionnaire on which they evaluated the accuracy of 3 prescriptions and indicated the type of error found, if any. The number of correctly identified prescribing errors and the number of correct types of errors identified were compared and error identification rates for each group were calculated.

Results. One hundred seventy-five questionnaires were returned (87% response rate). Pharmacy students had a significantly higher error-identification rate than medical and nursing students (p < 0.001). No significant differences were found between medical and nursing students (p = 0.88). Compared to medical students, pharmacy students more often were able to identify correctly the error type for each prescription (p < 0.001; p = 0.023; p = 0.001).

Conclusions. Of the 3 student groups, pharmacy students demonstrated a significantly higher erroridentification rate, which may be associated with the greater number of pharmacology and pharmacotherapeutics course hours that pharmacy students complete.

Keywords: prescription, medication error, simulation

INTRODUCTION

Approximately 2% of all patients admitted to hospitals in the United States experience a medication error. 1,2 Medication errors may have devastating, far-reaching consequences, not limited solely to patients and their families. Other individuals affected by medication errors include prescribing physicians, nurses administering the medication, and pharmacists filling and evaluating prescription orders. Many medication errors result from prescribing errors, which have an increased potential for serious complications.³⁻⁶ Prescribing errors are classified into different categories based on knowledge, rules, action, and memory. Knowledge-based errors reflect lack of experience or understanding about certain medications. Rule-based errors reflect lack of application of fundamental rules. Actionbased errors are those that are not intended (eg, misspelling or mistaken drug name). Memory-based errors involve forgotten information (eg, patient allergy). One study found that most prescribing errors were attributed to: (1) lack of

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information about the patient; (2) specific drug therapy (eg, narrow therapeutic index medications); or (3) inability to incorporate patient-specific factors (eg, declining renal function) to appropriate selection and dosing of drug therapy. Other errors result from miscalculations, improper use of decimal points, unit or rate expressions, and nomenclature.⁸

Understanding the types of errors and contributing factors to prescribing errors provides opportunities for error prevention at the earliest point of the medication process. Teaching pharmacy, medical, and nursing students to identify prescribing errors improves patient care and prevents potential adverse events. For many of these students, clinical experiences or clerkships are the first opportunity to observe drug therapy initiation and participate in prevention and identification of prescribing errors.

Although prescribing errors have been studied extensively, most research has focused on the types, causes, or prevention of errors in hospital and outpatient practice settings, covering a spectrum of patient populations from pediatric to geriatric. ^{9,10} To our knowledge, no studies have analyzed the ability of pharmacy, medical, and nursing students to identify prescribing errors. Information specific to health professional students' knowledge of prescribing errors may provide data for the future development of educational tools as part of health care professional training. Earlier training that focuses on medication error prevention,

especially those in the educational setting, may aid in reducing future incidence of medication errors in the patient care setting. The objective of this study was to assess and compare prescribing-error identification rates among pharmacy, medical, and nursing students.

METHODS

A questionnaire designed to assess the ability of health professional students to identify medication-prescribing errors was used in this prospective, observational study. Medical (MD), pharmacy (PharmD), and nursing students (bachelor of science in nursing [BSN], first degree program) enrolled in their last classroom lecture-based year were invited to participate. The final classroom training periods occur in the third year for pharmacy, second year for medical, and fourth year for nursing students. Students were allowed 10 minutes to complete the questionnaire, which was administered during clinical rotation/clerkship orientation for medical students, and at the beginning or end of a regularly scheduled class period for pharmacy and nursing students. Only students who attended the specific class session were eligible to participate in the study. The primary outcome measure was the number of correctly identified prescribing errors. The secondary outcome measure was the number of correct types of errors identified. Error identification rates for each group also were calculated. This study was approved by the University Institutional Review Board.

The questionnaire consisted of 3 fictitious patient prescriptions and additional patient-related information (name, date of birth, weight, diagnosis for the prescription under consideration, drug allergies, and current medications) that may assist in students' decision making. 11 Common types of prescribing errors presented in the questionnaire included wrong drug name and incorrect dosage calculations (Appendix 1). 8

Prescription 1 contained a look-alike/sound-alike medication. Aripiprazole is an atypical antipsychotic medication that is not indicated for the treatment of gastroesophageal reflux (GERD). Aripiprazole can be confused with omeprazole, which is a proton pump inhibitor used in the treatment of GERD. Prescription 2 contained warfarin and had no identifiable errors; however, it was included to discourage guessing. Prescription 3 contained a calculation error for a high-risk population (ie, pediatrics). Specifically, the acetaminophen in this example was dosed at 25 mg/kg/dose, which is a much higher dose than recommended (ie, 10 mg/kg). A pharmacotherapy expert reviewed the prescriptions for face validity, and edits to the prescriptions were made pursuant to his recommendations, prior to the administration of the questionnaire.

The questionnaire was designed so that the prescription and accompanying information were presented first,

and then participants were asked to answer the following question: "Is this prescription correct as written?" If the students responded "No," they were asked to select a reason why they felt the prescription was incorrect. The reasons included: (1) drug-allergy interaction; (2) wrong dosage; (3) wrong directions for use; (4) wrong route or dosage form; (5) wrong duration of therapy; (6) drug-drug interaction; (7) wrong drug for indication; and (8) drug-condition interaction. 12 A comments section was provided for students to further explain their reasoning. Participants were not allowed to use any resource materials (eg, drug dosing reference) to complete the questionnaire. Demographic information, including participant's age, years of college prior to entering the current program, college degrees, years of medically-related work experience, and grade point average (GPA), were collected to determine whether there was an association with medication or error-identification knowledge.

Data from the questionnaire were entered into SPSS (SPSS, Inc, Chicago, IL) for analysis. A chi-square test was conducted to determine error-identification rates for each group and for comparisons between-groups (medicine, pharmacy, and nursing). The demographic data were analyzed using ANOVA, Tukey's HSD post hoc test. A Poisson regression analysis was performed to identify whether years of health-related work experience was associated with questionnaire score. The *a priori* alpha level was 0.05. Bonferroni corrections were used in cases of multiple testing.

RESULTS

Of the 201 questionnaires distributed, 175 were returned (87% response rate). Response rates for each of the student groups included: 61 of 70 medical students (87%), 74 of 81 pharmacy students (91%), and 40 of the 50 nursing students (80%).

Differences in demographic characteristics (Table 1) were observed among the groups. Nursing students were significantly younger than pharmacy (p = 0.007) and medical students (p = 0.002). Additionally, there were significant differences in the number of years in college prior to starting the current program (pharmacy vs. medicine, p <0.001; pharmacy vs. nursing, p = 0.003; medicine vs. nursing, p < 0.001). Medical students had the most years of college education (4.4 \pm 1.1 years, p < 0.001) while nursing students had the least (2.8 \pm 0.9 years, p = 0.003). The medical student group had a significantly greater proportion of students with a bachelor's degree (100%) compared to pharmacy (39%, p < 0.001) and nursing (5%, p <0.001). Pharmacy students had significantly more years of medically related work experience than medical students (3.4 \pm 2.5 years, p = 0.047). No significant differences in GPA were observed between pharmacy and

Table 1. Demographics of Pharmacy, Medicine, and Nursing Students Who Participated in a Study on the Identification of Medication Errors

Variable	N	Mean (SD)	vs. Pharmacy, p	vs. Medicine, p	vs. Nursing,
Pharmacy	70	26.0 (4.8)	-	0.810	0.007
Medicine	59	26.0 (4.3)	0.810	-	0.002
Nursing	39	23.0 (4.6)	0.007	0.002	-
Years of College, y					
Pharmacy	72	3.4 (1.4)	-	< 0.001	0.003
Medicine	60	4.4 (1.1)	< 0.001	-	< 0.001
Nursing	37	2.7 (0.9)	0.003	< 0.001	-
Work Experience, y					
Pharmacy	66	3.4 (2.5)	-	0.047	0.071
Medicine	55	2.1 (3.8)	0.047	-	0.97
Nursing	30	1.9 (2.4)	0.071	0.972	-
Grade Point Average					
Pharmacy	68	3.6 (0.3)	-	-	0.61
Medicine ^a	-	-` ´	-	-	-
Nursing	35	3.5 (0.3)	-	-	0.61

^a Medical students at The University of Arizona College of Medicine do not have grade point averagess, rather a pass/fail grading system is used.

nursing students (p=0.61). A GPA for comparison was not available for medical students due to the pass/fail grading system used by the school/university. More medical students already had earned a bachelor's degree compared to pharmacy and nursing students ($p \le 0.003$). Six nursing students reported having earned an associate's degree.

The mean percent of correctly identified errors (Figure 1) differed among the groups (p < 0.001). Pharmacy students mean score was 2.2 ± 0.8 out of 3 correct, which was significantly higher than the mean scores of medical students (1.3 ± 0.9), and nursing students (1.3 ± 0.9). There was no significant difference between scores of medical and nursing students on this outcome measure (p = 0.65). A Poisson regression analysis indicated the number of years of work experience was not a significant predictor of correct answers on this assessment (p = 0.33).

For prescription 1 (look-alike/sound-alike error; Figure 2), more pharmacy students than medical or nursing students were able to identify the error type correctly (p < 0.001 for each comparison). No difference between medical and nursing students' ability to identify the error was found (p = 0.31) for this prescription. For prescription 2 (no error), significantly more pharmacy and medical students than nursing students were able to identify that the prescription did not contain an error (p < 0.015 for each comparison). No significant difference was identified between pharmacy and medical

students' scores on this question (p = 0.023). For prescription 3 (pediatric calculation error), more pharmacy students were able to identify the error type than medical students (p < 0.001), but no other differences were identified for this item (p = 0.14 and p = 0.17).

DISCUSSION

To our knowledge, no studies to date have analyzed the ability of health professional students to identify prescribing errors immediately following lecture-based training. In

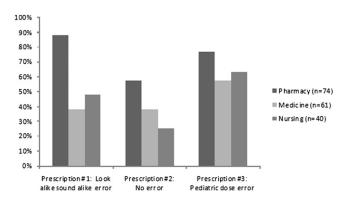


Figure 1. Percent of students in each professional group who correctly identified each prescription as having or not having an error. Significant differences were identified among the following groups: Prescription 1: pharmacy and medicine (p < 0.001); pharmacy and nursing (p < 0.001); Prescription 2: pharmacy and nursing (p < 0.001); Prescription 3: pharmacy and medicine (p < 0.015)

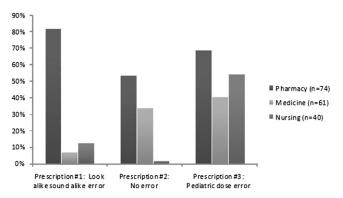


Figure 2. Percent of students in each professional group who correctly identified prescription problem type. Significant differences were identified among the following groups: Prescription 1: pharmacy and medicine (p < 0.001); pharmacy and nursing (p < 0.001); Prescription 2: pharmacy and nursing (p < 0.001); medicine and nursing (p < 0.001); Prescription 3: pharmacy and medicine (p < 0.001).

this study, pharmacy students correctly identified more prescription errors than medical and nursing students, which is not surprising as pharmacy students complete more drug-related courses than either medical or nursing students. At our institution, medical students receive approximately 115 hours of lecture-based pharmacology and therapeutics instruction, while pharmacy students receive approximately 250 hours. Coverage of these topics in the nursing program was more difficult to assess because the curriculum is integrated, and hours of pharmacology and therapeutics were difficult to tabulate. Thus, differences in error-identification rates may reflect the amount of drugrelated education in each of the respective curricula. The pharmacy school curriculum focuses primarily on medications and their mechanisms of action, resulting in more course time spent on medications in this program, compared to medical and nursing programs. Repetition and familiarity with medications also may contribute to pharmacy students' ability to identify prescribing errors correctly. These results support the need for checks and balances in the prescribing process and further confirm the need for the pharmacist as an active member of the patient care team.

While more pharmacy students than medical students were able to identify the error type in prescription 3 (pediatric calculation error), no significant difference between pharmacy and nursing students was found. At the study institution, medical students receive approximately 4 hours of pediatric specific pharmacology instruction, and pharmacy students receive approximately 12 hours. As explained above, because of the integrated nursing curriculum, the hours of lecture-based pediatric pharmacology and therapeutic instruction were not estimable. However, nursing faculty members indicated that there

is a programmatic focus on medication safety and appropriate dosing for pediatric patients throughout the pediatric clinical practicum. Because prescription 3 addressed pediatric dosing of acetaminophen, performance on this question may be attributed to life experience (ie, students who had work-related or personal experience in caring for a child may have been familiar with pediatric dosing of this commonly recommended nonprescription product).

The only significant difference between medical and nursing students' identification of error types was the ability to identify correctly the type of error in prescription 2 (no error). This prescription was designed as a quality control measure to help determine whether positive error identification was due to individual knowledge rather than guessing. This difference among students may represent the application of more drug-related knowledge by medical students, whereas nursing students may have guessed, assuming that there was an error.

The ability to recognize prescribing errors by this group of health professional students was suboptimal. All pharmacy students, and most medical and nursing students, were able to identify the error in at least 1 prescription correctly. Six (9.8%) medical students, 32 (43%) pharmacy students, and 3 (7.5%) nursing students correctly identified the error in all 3 prescriptions. Regardless of professional training, these health professional students exhibited a considerably low ability to identify prescribing errors. Thus, study findings support the need for additional medication error-identification and therapeutics education for medical, pharmacy, and nursing students at the study institution and perhaps at other US institutions as well. Improving the prescribing error-identification ability likely leads to better prescribing practices, thereby producing better patient outcomes.

Notably, the study respondents were not permitted to use additional resources such as reference books or electronic media to assist them in completing the questionnaire. This may not reflect a real-life practice setting because most clinicians do have access to drug-related resource information. However, the availability of resource materials has not obviated the need for health care providers to have a solid understanding of medication therapy. Therefore, all members of the health care team must be familiar with appropriate medication therapy to identify, prevent, and amend therapy as needed.

Although significant differences were observed among the study groups relative to age, years of college, medicalrelated work experience, and having received a bachelor's degree, these differences may reflect the requirements of each program. For example, medical students must have a bachelor's degree before entering their professional program; thus, there is a higher proportion of students with baccalaureate degrees among this group. Medical students

also may be older than pharmacy and nursing students due to the amount of time required to complete a bachelor's degree. Demographic differences among groups may make it difficult to compare results; however, this may not be the case for this sample population. For example, the nursing students were younger than the pharmacy and medical students and had significantly less work experience and years of college. Despite this difference, the nursing group's accuracy in identifying the error in prescription 3 (pediatric calculation) did not differ significantly from the pharmacy group. Another difference among the groups was the number of years of professional experience. Many pharmacy students work as pharmacy technicians or interns and have repeated exposure to these drug regimens during these work experiences. Medical and nursing students are more likely to be exposed to medications and prescribing later in their curricular programs; thus, they may become better able to identify prescribing problems at that time. However, the number of years of work experience was not a significant predictor of correct answers on this assessment (p = 0.33).

This study had several limitations. The sample population may not have been representative of the entire population of medical, pharmacy, and nursing students in the United States. Also, there was self-selection bias because students elected whether to participate. This fact may have skewed the results if only students who felt they knew the correct answers chose to submit their completed questionnaires. Additionally, only 3 prescriptions were used in the study and these contained only 2 error types. Had a variety of error types been incorporated into the prescriptions, or if more prescriptions containing errors had been provided to the students, stronger conclusions regarding differences among the types of health professional students could be made. Thus, additional research in this area is needed.

This study assessed the medication-error identification abilities of health professional students. Results will be added to other evidence to serve as part of a needs assessment for future training. The authors intend to create and offer a medication-error educational session designed specifically for health professional students. Following the session, students will be asked to complete an immediate post-training evaluation, which will be based in part on the evaluation used in this study. The authors plan to evaluate curricular content and conduct a longitudinal analysis to determine prescribing error-identification in these student groups. In addition, a follow-up focus group with the students may reveal useful qualitative information about questionnaire format or content, or other subtleties in their responses that were not captured in the quantitative analysis.

CONCLUSION

Pharmacy students identified more prescribing errors than medical and nursing students, perhaps due in part to the greater number of required pharmacology and pharmacotherapy course hours in the pharmacy curriculum compared to that of medical and nursing students. Medical and nursing students had similar error identification rates for all 3 prescriptions. Pharmacy students were more likely than medical or nursing students to identify correctly the type of prescribing error. More pharmacy students correctly identified prescribing errors in all 3 prescriptions. Most students in the study correctly identified at least 1 prescribing error; thus, all 3 groups of health professional students are capable of playing an important role in preventing and reducing the number of medication errors. However, further research is needed to determine the most appropriate teaching methods to increase prescribing error-identification. Future studies not only will serve to enhance professional education, but also to optimize patient medication safety.

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Appendix 1. Assessment Instrument

For each of the 3 prescriptions below, use the patient information to determine if there are any prescribing errors. If there are, please indicate the type of error you found.

Prescription 1

Name: GT Diagnosis: GERD

DOB: 7/14/81 Drug Allergies: None

Weight: 65 kg

Current Medications: Multivitamin PO Q Day

Name: GT DOB: 7/14/81 Address: 123 E. 4th Place, Tucson AZ 85745

Aripiprazole 20 mg PO Q day for GERD

#30

- 1. Is this prescription correct as written? (circle)

 - Yes
- 2. If not, please indicate the type of error you found. (circle)

Drug-Allergy interaction

Wrong dosage

Wrong directions for use

Wrong route or dosage form

Wrong duration of therapy

Drug-Drug interaction

Wrong drug for indication

Drug-Condition interaction

3. Comments (optional):

Prescription 2

DOB: 3/7/1952 Name: SL Diagnosis: Atrial Drug Allergies: Fibrillation Penicillin

Weight: 60 kg

Current Medications: TUMS 1-2 tablet PO prn

heartburn

Name: SL DOB: 3/7/1952 Address: 456 E. 4th Place, Tucson AZ 85745

Warfarin 5 mg PO Q day #30

- 4. Is this prescription correct as written? (circle)
 - Yes
- 5. If not, please indicate the type of error you found. (circle)

Drug-Allergy interaction

Wrong dosage

Wrong directions for use

Wrong route or dosage form

Wrong duration of therapy

Drug-Drug interaction

Wrong drug for indication

Drug-Condition interaction

6. Comments (optional):

Prescription 3

Name: TB DOB: 4 month old Diagnosis: URI, fever Drug Allergies: none

Weight: 5 kg

Current Medications: none

Name: TB DOB: 4 months old Address: 789 E. 4th Place, Tucson AZ 85745

Acetaminophen 80mg/0.8 mL, Give 1.25 mL PO q 4-6 hours prn fever no more than 5 doses per day

#4 ounces

- 7. Is this prescription correct as written? (circle)
 - Yes
- 8. If not, please indicate the type of error you found. (circle)

Drug-Allergy interaction

Wrong dosage

Wrong directions for use

Wrong route or dosage form

Wrong duration of therapy

Drug-Drug interaction

Wrong drug for indication

Drug-Condition interaction

9. Comments (optional):