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INSTRUCTIONAL DESIGN AND ASSESSMENT

Evaluating Internet-based Multimedia Vignettes for Teaching Ophthalmic and Otic Drug Administration Techniques

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Objective. To ascertain pharmacy students' knowledge of ophthalmic and otic medication administration procedures and to evaluate the effect of ultra-short training clips to efficiently teach these medication administration techniques.

Methods. Three Internet-based 90-second multimedia vignettes for ophthalmic and otic administration techniques were developed. First- and second-year students were shown the vignette; students completed a pretest and posttest.

Results. Students' ophthalmic and otic test scores improved significantly ($p<0.001$and $p<0.001$, respectively) after viewing the multimedia vignettes.

Conclusion. Computer-based vignettes demonstrate promise as a primary or supplementary instruction tool for teaching medication administration techniques.

Keywords: internet, multimedia, drug administration techniques, ophthalmic, otic

INTRODUCTION

Based in part on findings from standardized patient comprehensive skills testing by the University of Arkansas for Medical Sciences (UAMS) College of Pharmacy's Pharmaceutical Care Evaluation Program (PCEP), opportunities were identified for enhanced training in ophthalmic medication counseling. Standardized patients are often used to assess student skills in the integration of didactic knowledge, communication abilities, and critical thinking.[1-4] Ophthalmic product administration instruction occurs within the first semester of our curriculum. Two years later, in the third year, students complete a 10-station skills assessment PCEP. In the particular year that ophthalmic administration skills were evaluated (the station scenarios and skills tested change every year), opportunities for enhanced ophthalmic product administration training were identified. PCEP results of student skills using an 8-skill ophthalmic checklist (Appendix 1) produced an average score of 20.7 "skill points" out of a possible 25. This revealed to our faculty members that students were not fully assimilating typical instruction to the level that the faculty members expected, and provided an opportunity for improving instruction within our curriculum. Those who have experience with PCEP evaluations are not surprised when students do not score as well as anticipated. This ophthalmic PCEP administration skills testing was no exception.

Health statistics indicate that high volumes of ophthalmic and otic medications are prescribed and dispensed annually. In the year 2003, the ophthalmic and otic drugs in the top 200 brand and generic drugs list accounted for 39.4 million individual prescriptions.[5] Based upon the sheer number of prescriptions written annually for ophthalmic and otic medications and the importance of proper administration of these agents, attention was focused on the importance of verifiable specialized training in administration techniques for ophthalmic and otic medication.

After identifying opportunities to correct deficiencies in the students' knowledge base, computer-delivered training was considered an option for improving students' performance. Further, by using the Internet, this resource material would be readily available for the students during their practice experiences and professional maturation. Accessible interactive Internet-based multimedia training vignettes presented by experts have the potential to improve student training and subsequent patient care. Within pharmacy curriculums, computer-aided learning (CAL) has been used for patient encounter simulations[6] and pharmacology instruction.[7] In a medicine anatomy curriculum, CAL has proven an effective supplement for student learning.[8] One nursing curriculum describes the use of CAL to teach students how to administer medicines.[9]

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The effectiveness of patient counseling by practicing pharmacists is based in part upon their college training. Thus, it is important to evaluate the students' knowledge base for ophthalmic and otic drop administration techniques and to develop efficient, effective, and validated instructional methods for either primary training or supplemental training. Other colleges may be interested in the success of our experience to assess, convey, use, or collaborate on similar Internet-based training initiatives.

The objectives of this study were:

- to evaluate the utility of an Internet-based multimedia presentation to efficiently train students in correct ophthalmic and otic medication administration techniques;
- to ascertain students' knowledge of correct ophthalmic and otic medication administration techniques following traditional instructional methods;
- to evaluate the use of Internet-based multimedia presentations to efficiently serve as a "booster" resource to augment students' administration technique knowledge;
- to describe students' perceptions of computer-based multimedia presentations in specialized medication administration training.

METHODS

This study was reviewed and approved by UAMS Investigational Review Board (IRB) and was conducted in accordance with all Federal regulations regarding human subject research.

Three Internet-based 90-second multimedia vignettes demonstrating correct administration techniques were developed. The developed training vignettes included the following:

- proper ophthalmic drop administration
- proper otic drop administration in an infant
- proper otic drop administration in children over 3 years of age and adults

Upon development of the vignettes, faculty members responsible for the instruction of techniques for administering eye and ear drops reviewed the vignettes to check for content validity (eg, accuracy, completeness). The vignettes were edited based on the faculty members' comments and suggestions.

The proprietary developmental and delivery software used in production of the vignettes included: *Ulead Video Studio 8* for digital movie editing, *PowerPoint* for slide show development, *Impatica* for compression, and *Impatica OnCue*. *Impatica OnCue* allows for synchronization of "Impaticized" Microsoft *PowerPoint* files, highly compressed AVI digital video and audio files, with simultaneous synchronized scrolling text which is similar to karaoke delivery. A searchable text feature as well as a control panel with dynamic indexing and navigation for replays of individual synchronized slides is optional to the viewer. The viewer can select the "bandwidth" delivery and degree of compression that are optimal for the speed of his or her Internet connection. Alternatively, all content can be placed on a CD or DVD for viewing.

Subject Recruitment

Subjects were recruited from the first- and second-year UAMS pharmacy classes. The investigators first made introductory remarks and then informed the class of the research project. Students participated in the study during a regularly scheduled class period and participation was voluntary. Furthermore, the students were informed that the investigators would not know whether any individual student participated and that the test would take approximately 50 minutes to complete. The actual time to deliver the content of the 3 Internet-based multimedia study materials was less than 5 minutes.

First-year students were evaluated on administration counseling knowledge both before and after watching the Internet-based vignette. Second-year students were evaluated for retained knowledge from "traditional instruction," which occurs within the first semester of the first academic year. Second-year students were then re-evaluated after viewing the Internet-based training vignette.

Data Collection

Students responded using a commercially available audience response system , the Classroom Performance System (CPS) [eInstruction Corporation, 308 N. Carroll Blvd., Denton, TX 76201]. This system allowed students to input their responses to questions via remote control devices using buttons labeled A, B, C, D, E, and F. CPS remotes are similar to television remote control devices. Questions were projected on a screen in the classroom and each available response corresponded to a letter on the remote control device. Each transmitter is uniquely identified by the computer and all responses are immediately and individually captured.

These transmitters were handed out randomly. Students not wishing to participate were given a device anyway, but did not enter responses during the presentation. Authors were unable to ascertain who participated and who did not, but were able to determine the exact number of students participating. Captured results can be exported to a spreadsheet or database program.

Table 1. First-Year and Second-Year Pharmacy Students' Test Scores on Ophthalmic and Otic Drug Administration Techniques Before and After Viewing Multimedia Training Vignettes

	First-Year Pharmacy Students' Responses n=76			Second-Year Pharmacy Students' Responses n=74			First- vs. Second-Year Pretest Scores
Questions	**Pretest % Correct**	**Posttest % Correct**	***P***	**Pretest % Correct**	**Posttest% Correct**	***P***	***P***
17. How far do you hold the dropper from the eye when administering ophthalmic drops?	79	99	<0.0005*	88	95	0.133	0.146
18. If the eye is crusty, do you clean the eye before administration of ophthalmic drops?	63	99	<0.0005*	87	99	0.002	0.001*
19. If you clean the eye, you do so with a moistened cotton swab swabbing which way?	46	99	<0.0005*	61	95	<0.0005*	0.071
20. After drop(s) are placed in the eye, the first order of business is?	1	8	0.024	37	35	0.820	<0.0005*
21. If you were going to place your finger on the eye after instilling eye drops, where would you apply pressure with you finger?	29	90	<0.0005*	92	96	0.181	<0.0005*
22. Can you put otic drops in the eye?	84	96	0.012	89	100	0.004	0.373
23. Where would you hold the dropper in relation to the ear?	67	96	<0.0005*	72	100	<0.0005*	0.552
24. Which direction do you pull an adult's ear to open the ear canal?	20	79	<0.0005*	49	95	<0.0005*	<0.0005*
25. Which direction do you pull an infant or young child's (less than 3 years old) ear to open the ear canal?	36	95	<0.0005*	41	89	<0.0005*	0.530
26. How long do you remain with the ear facing up to allow the medication to soak in?	21	99	<0.0005*	22	99	<0.0005*	0.933
27. Can you put Ophthalmic drops in the ear?	63	95	<0.0005*	93	100	0.024	<0.0005*

*statistical significance at P=0.0015

Regardless of whether they elected to participate, students watched the training video as an educational component of the class.

Before actual testing took place, several questions were projected and the participants responded to each question in a warm-up practice exercise to familiarize the first-year students with the student response system and to refresh the understanding of the system to the second-year class. This was important to the first-year class because this was their first exposure to the audience response system. The second-year class had minimal earlier exposure to the student response system in another course not associated with this study. Fortunately, the audience response system is quite intuitive and we only observed one student struggling with the response transmitter.

After practice questions and demographic questions were asked, a pre-knowledge test was administered using the audience response system (Table 1, questions 17-27). The warm-up questions and pretest questions occurred sequentially without interruption.

Upon completion of the pretest, 3 Internet-based, 90-second vignettes were shown that illustrated the correct administration techniques for ophthalmic and otic preparations. (A sample vignette is available at: http://www.uams.edu/classinformatics/movie/ear-adu.html.) After the vignettes were presented, a posttest was administered using the same procedure used for the pretest, but without warm-up questions. The posttest included questions about the instructional benefit and effectiveness of the vignettes.

Table 2. Pharmacy Students' Perceptions of Multimedia Vignettes for Training Teaching Ophthalmic and Otic Drug Administration Techniques

	Percent of First-Year Students	Percent of Second-Year Students
28. These short videos were helpful.		
A. Strongly disagree	9	3
B. Somewhat disagree	0	1.4
C. Neither agree or disagree	12.5	4.1
D. Somewhat agree	32.8	43
E. Strongly agree	45.3	48.6
29. These short videos were a useful refresher.		
A. Strongly disagree	11.3	2.8
B. Somewhat disagree	6.5	1.4
C. Neither agree or disagree	22.6	4.2
D. Somewhat agree	22.6	26.4
E. Strongly agree	37.1	65.3
30. I learned new information from these vignettes.		
A. Strongly disagree	11.4	6.9
B. Somewhat disagree	2.3	9.7
C. Neither agree or disagree	20.5	15.3
D. Somewhat agree	25.0	33.3
E. Strongly agree	40.9	34.7
31. I would find these vignettes useful in my practice as a pharmacist to help counsel patients.		
A. Strongly disagree	No results	1.4
B. Somewhat disagree	No results	1.4
C. Neither agree or disagree	No results	2.7
D. Somewhat agree	No results	37.8
E. Strongly agree	No results	56.8

The Internet-based content and the audience response system for classroom delivery were tested for reliability before each class period to minimize the potential for technical difficulties.

Knowledge Test

Questions to assess ophthalmic and otic administration knowledge and techniques were developed for the pretest and posttest. After the development of the knowledge test, faculty members who instruct ophthalmic and otic drop administration were consulted for content validity. The test was revised according to their suggestions.

Before conducting the experiment, a pretest was conducted using a few practitioner subjects. Pre-testing was conducted to test the instructions, treatment manipulations, and computer-projected questionnaire. Feedback from the trial run was used to modify the test instrument, improve parts of the study design, and to edit the questionnaire.

Analysis

Students who did not answer over half of the questions were excluded from the analysis. Means and standard deviations were calculated for each scale and each item. Otic and ophthalmic test scores were analyzed using paired *t* tests at the 0.05 level of significance. Paired *t* tests with Bonferroni correction for item-wide testing were used and statistical significance for individual items was set at the 0.0015 level of significance.

RESULTS

Eighty-three first-year students and 75 second-year students participated in the study. To compare test scores, only students who completed the tests were included in the analysis. Thus, test scores for 76 first-year students and 74 second-year students were analyzed.

Ophthalmic and otic test scores for first-year students were significantly different between pretest and posttest ($p<0.001$, $p<0.001$, respectively). Pretest to posttest statistical improvement occurred in 9 of the 11 questions for the first-year class (Table 1). Similarly, ophthalmic and otic pretest and posttest scores for second-year students were significantly different ($p<0.001$, and $p<0.001$, respectively). Pretest to posttest improvement occurred in 5 of the 11 questions for the second-year class (Table 1). Since the second second-year students learned the material a year earlier, it would be expected that that there would be less individual questions with statistically significant improvement in the second-year class.

As expected, second-year students' knowledge after traditional instruction occurring 1 year earlier was better than first-year students' knowledge before any instruction. However, the results found in Table 1, indicate that opportunities for "booster" training exist for second-year students.

Student perceptions of Internet-based CAL are noted in Table 2 and were favorable.

DISCUSSION

The first objective was to evaluate the utility of Internet-based 90-second multimedia computer presen-

tations to train students in correct ophthalmic and otic medication administration techniques. The authors found improvement between the students' pretest and posttest knowledge in most administration technique questions studied (Table 1). For the one question concerning placement of otic drops in the eye, most students answered correctly without any instruction; therefore, significant improvement from pretest to posttest was not expected. The results demonstrate that these Internet-based training vignettes show considerable promise for imparting knowledge about administration technique. As expected, first-year pharmacy students scored lower in their pretest knowledge than second-year students who had the benefit of traditional instruction a year earlier (Table 1). These improvements in scores by first-year students were higher than the amount of retained information from traditional instruction by second-year students. Further study is needed to ascertain how much of that difference is due to second-year students' memory loss over a year's time.

The second objective pertained to ascertaining students' knowledge of correct ophthalmic and otic medication administration techniques following traditional instruction methods. Students performed well on traditional tests administered within the semester when the administration procedure instruction occurred. Later during comprehensive skills PCEP testing in the third year, opportunities for additional instruction were identified.

With the expected outcome following traditional instruction, that students lose their knowledge and skills over time, the authors considered using Internet-based learning to augment traditional instruction. Alternatively, in didactic courses in which curricular resources are readily available to remediate identified weaknesses, standard laboratory instruction in administration techniques could be considered. It was found during our evaluation that considerable medication administration knowledge faded between the first semester of the first year and the first semester of the second year (Table 1). These skills should be constantly maintained, not only over the time the student is in the curriculum, but during the entire time of professional practice to ensure optimal patient counseling.

The third objective was to determine the utility of multimedia computer presentations to efficiently serve as a "booster" resource to augment student knowledge. For second-year students, for whom these vignettes were being evaluated to enhance baseline knowledge, significant improvement in knowledge occurred within 5 of the 11 skill questions studied. Improvement was probably not seen for the other 6 items because the second-year students scored high on these items on the pretest. Thus, the students retained some information and forgot some information from the previous year. With the efficiency of these 90-second vignettes, the authors believe significant opportunities exist to use Internet-based multimedia resources in other scenarios. Although the authors do not advocate the use of these vignettes to replace traditional instruction, vignettes do have the potential for this use and require further study. With student absences, students losing concentration during typical classroom instruction, and students simply not understanding the topic the first time around, these vignettes could serve as a resource for specific topics within traditional instruction. Further, these vignettes by nature of being located on the Internet are available to students with Internet access during their practice experiences. Alternatively, the vignettes can be placed on a CD or DVD for the student to carry to their practice sites.

Finally the students' perceptions of the usefulness of these vignettes exceeded the authors' expectations (Table 2). Although all numbers were favorable from an instructor's standpoint, of particular note, second-year students overwhelmingly believed the vignettes were useful as an informational "booster." For first-year students, this was not refresher training but a first exposure to instruction in administration techniques for ophthalmic and otic medications. This may have led to the disparity in responses between the first- and second-year students about whether the vignettes were a useful refresher (Table 2, question 29). Additionally, in the first-year class, the authors ran out of time and the fourth perception question (Table 2, question 31) was not asked, which accounts for the lack of responses within that table. For the small number of students who did not like the vignettes (Table 2), the authors were unable to determine whether the students disagreed because they already knew the information, if the quality of the vignettes was the issue, or if the cause was the students' unfamiliarity with this training tool. Knowing that there would be time constraints during the class period, the authors did not determine the reasons for students not liking the vignettes. It could also be that those students simply did not like the vignettes or the instructors, or elected to be difficult during the anonymous polling. Our students had little early exposure in self-directed computer-aided learning. The small percentage of students who did not like the vignettes may reflect this unfamiliarity or lack of experience with this instructional method. The authors concede that the production was done in house and several "spliced" sections of the vignette led to some choppiness in the production. A better-funded multimedia

production would utilize graphic design artists and professional photographers.

Colleges of pharmacy recognize the importance of teaching computer skills and technological advancements in pharmacy practice because it is an accreditation skill required by the Accreditation Council for Pharmacy Education (ACPE). Oddly, the use of computers to teach general or specialized practice skills varies by college. Although ACPE recognizes the importance of technological advancements in practice, colleges of pharmacy have been slow to develop technological advancements in pharmacy instruction. The use of CAL in pharmacy curriculums leaves considerable room for development and study. Perhaps the sporadic development of CAL in pharmacy curriculums is because of the tremendous amount of development time and specialized skills required, as well as expensive software and hardware, to produce teaching materials. This is coupled with a perceived lack of recognition of this instruction method by promotion and tenure committees. Perhaps only through collaborative efforts between colleges of pharmacy or via sufficient grants will the critical mass for establishing a compendium of quality computer-based training materials be available for incorporation throughout our curriculums. Whether or not faculty members have a realistic perception of the academic value of CAL should not delay the study of the effectiveness of CAL as a primary method of instruction or to augment traditional classroom or clerkship instruction.

The findings of this study stand to contribute to the evaluation of the students' knowledge required for the administration of an important group of medications. Moreover, the study findings indicate the potential of ultra-short Internet-based vignettes in training students. These vignettes could be extrapolated and studied for other skill-based issues (eg, various physical assessment procedures, or other specialized patient counseling techniques such as inhalers, insulin injection, etc.)

Further, the need to better understand the working knowledge base of students in their provision of information to patients can lead to studies involving specialized pharmaceutical products. The effectiveness of using ultra-short multimedia training vignettes for other health professionals or for the direct training of the end user, the patient, can also be studied. Finally, the true "base knowledge" of practicing pharmacists is not known, nor is it known whether pharmacists have the time to counsel their patients even when they do possess these skills. Because of the limited amount of time pharmacists have secondary to heavy dispensing workloads, these multimedia vignettes with playback capability have tremendous potential for direct patient training. This training could occur in existing drug store "computer kiosks" or be available in highly compressed format for worldwide Internet access.

Limitations

Although 2 large groups of students were studied, the study design would fall into Campbell and Stanley's pre-experimental, one-group pretest and posttest design.[10] The use of a control group within the study was not feasible from a curriculum standpoint. Another limitation was the lack of data showing how much knowledge is retained over time. A time-series study showing the effectiveness of the videos with a control group is warranted. Finally, specific follow-up evaluation with students who did like the vignettes was not undertaken. Even with these limitations, the results indicate that vignettes show considerable promise as either a primary training tool or refresher to student's knowledge.

CONCLUSIONS

Opportunities exist in the evaluation of the utility of a multimedia computer presentation to efficiently serve as the primary instructional method to train students in correct ophthalmic and otic medication administration techniques. However, further study is required to determine the loss of information over time vs. the effectiveness of this training tool in direct comparison to traditional instruction. Secondly, in ascertaining second-year students' knowledge following traditional instructional methods in correct ophthalmic and otic medication administration techniques, opportunities for refresher instruction were noted 1 year after initial traditional training. In the evaluation of the use of multimedia computer presentations to efficiently serve as a "booster" resource to augment student's knowledge, statistically significant improvement occurred between pretest and posttest knowledge. Finally, students' acceptance and perceptions of computer-delivered multimedia to teach specialized administration techniques indicate this tool has considerable promise as an important resource in professional education.

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Appendix 1. Ophthalmology (Glaucoma) Checklist

Ophthalmology (Glaucoma) Checklist

«Student»

«ID»

Place SP/Faculty Label Here

Skill Checklist	PASS	FAIL
1. Eye drop administration technique: Student instructs patient to pull down the lower eyelid with a forefinger in order to form a "pocket" to receive the drop.	O	O
2. Eye drop administration technique: Student instructs patient that after placing the drop in the eye, the patient should close the eyelid for 1 to 3 minutes.	O	O
3. Eye drop administration technique: Student instructs patient that during the 1 to 3 minutes when the eyelid is closed, the patient should gently press an index finger against the inner corner of the eye.	O	O
4. Eye drop administration technique: Student instructs patient that the purpose of pressing an index finger against the inner corner of the eye is to prevent the drug from draining into the sinuses and being absorbed systemically. This can reduce side effects and improve the desired ophthalmic effect of the drug.	O	O
5. Eye drop administration technique: Student instructs patient to separate the administration of the 2 different drugs by at least 3 to 5 minutes (preferably 10 minutes) to prevent the first drug from being washed out by the second drug.	O	O
6. Eye drop administration technique: Student instructs patient to not touch the tip of the eyedropper to the eye, finger, or any other surface.	O	O
7. Student instructs the patient that she should not use the prednisolone eye drops again until she talks to her ophthalmologist about it.	O	O
8. Student informs the patient that the Xalatan® (latanoprost) can cause brown iris pigmentation to become darker.	O	O

Communication Checklist	PASS	FAIL
1. Introduces self/shakes hands	O	O
2. Provides information with confidence	O	O
3. Sensitive to needs of patient/situation	O	O
4. Student asks the standardized participant if she/he has any further questions	O	O

Overall Student Performance

O OUTSTANDING
O CLEAR PASS
O BORDERLINE
O CLEAR FAILURE