Evaluation of a Computer Simulation in a Therapeutics Case Discussion

Raenel E. Kinkade, Craig T. Mathews, JoLaine R. Draugalis[1] and Brian L. Erstad
College of Pharmacy, The University of Arizona, Tucson AZ 85721

Acknowledging computers as a valuable learning tool, we designed an interactive computer program, using the Adventure Game Toolkit. The program was a case presentation of a patient with open-angle glaucoma. Students were instructed to use their knowledge of glaucoma and the various topical agents on the computer program's "formulary" to "treat" the patient appropriately. Forty-eight students enrolled in PhPr 475c (Pathophysiology and Pharmacotherapeutics) at The University of Arizona College of Pharmacy were randomized. Twenty-four students completed the computer program while the remaining 24 students completed a similar case presentation on paper, according to the standard practice for that course. A ten-item quiz was subsequently administered to the two groups and the scores were analyzed using an independent t-test. We found no significant differences and concluded that the computer simulation was as effective as the case presentation on paper and recommend that further work be done in this area to allow instructors of pharmacotherapeutics courses another instructional option.

INTRODUCTION

Computers have become an increasingly important part of our society in this technological age. Already they are cornerstones of most businesses, large or small, and have made their way into millions of homes across the United States. As the business world has made widespread use of computers, the value of computers as an instructional tool has become acknowledged within the academic realm. Many instructional programs now exist for students of all ages and disciplines.

A search of the medical literature revealed that computer-assisted instruction is becoming more widely used in the medical and nursing school curricula(1-3). However, very few computer programs of this type are available for pharmacy students. Of those that have been developed, the majority do not appear to be distributed for use outside the institutions from which they originated.

One of the more comprehensive computer programs that has been developed specifically for pharmacy students was written by Hurst *et al*.(4) for augmenting instruction during the cardiology section of a pharmacotherapeutics course. The students in this course were randomized to

[1] Corresponding author.

receive the computer simulation, a written copy of the computer simulation, or a different case presentation that covered the same material. There were no differences among the groups with respect to performance on tests covering the cardiology material(4). Another interactive computer program was developed by Tunget *et al.*(5) for use in a drug information course. Tunget *et al.* also found that the computer program was as effective as traditional classroom instruction. The purpose of this project was to develop a computer case simulation for the disease state glaucoma and to test whether the simulation was equivalent to the standard written case study covering the same topic.

METHODS

The glaucoma computer-assisted patient simulation was developed using a Share-Ware program titled "The Adventure Game Toolkit" (AGT)(6). This toolkit uses a core program that translates a series of author-input data bases into a pseudo-Pascal programming language. After the initial literature review was completed, the programming process occurred over a period of six weeks and included writing the basic program, de-bugging, and adding enhancements. Approximate programming time was 250 hours with the majority of time spent writing the basic program and working out performance problems. The greatest difficulty was trying to adapt our ideas to the programming format dictated by AGT. Using a specified format, the authors define a series of nouns, verbs, rooms, commands, flags, and variables to be used and manipulated throughout the course of the simulation. The end program uses free text (input and output) to allow the "player" to guide himself or herself through the game to the case's conclusion.

Using the flags and variables to define possible patient responses to the various topical agents available for the students to use, it was possible to generate probabilities of the success or failure of any given single or combination therapy. In addition, probabilities of experiencing various side effects were also programmed into the simulation. These probabilities were based on a literature review of the agents used and their respective efficacies and frequency of side effects(7-16). This was done to provide the student with results that would most closely approximate what would be encountered in real life if these agents were used.

How The Program Works

The program works under a "choose your own adventure" scheme that ultimately requires the player to be in a "room" and transferring from room to room. Within the room, a player is allowed to manipulate certain nouns (items in the room) using a defined list of commands. Within the context of our simulation, there were two "rooms." The Baseline Room gives the patient presentation, baseline IOP, and lists the drugs available for use in therapy (these are seen as nouns by the program to be manipulated by the player). The other room is the follow-up room that gives the new IOP and side effect complaints. See Figure 1.

The flexibility and power of the program come from the use of commands, flags, and variables. The commands determine what input from the player will be understood by the program. If a player inputs a command that has not been defined, the program will print "I do not understand the word___." The player is then forced to use a command that is defined. Once a command is given, the program's parser examines the command input from the player and looks for

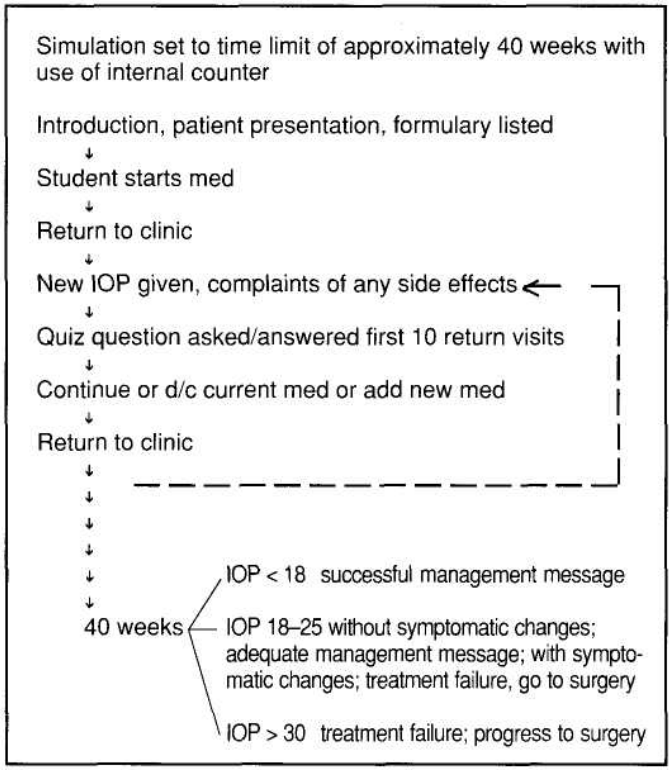

Fig. 1. Outline of simulation.

a verb and a noun as the object of the verb to decide how to deal with the command. The use of flags and variables determine the path that the computer will take to arrive at a new IOP for the patient. Flags are translated by the program into a series of "if-then" and "yes-no" statements as an elaborate binary decision tree. If flag 1 is turned on, X will happen and if it is off, Y will happen. In simple terms, if one set of flags is on, the IOP goes down; if it is off, there is either no change or the possibility that the IOP will increase. See Figure 2.

Variables play an integral part in turning flags on or off. For example, one flag was used to label the patient as a nonresponder who would be refractory to all treatment attempts. A variable was used to test the percent chance of turning this flag on (*i.e.*, five percent chance to turn the flag on). All of these elements allow a player to experience a different outcome every time a new game is started and this is the ultimate goal of the program. See Figure 3.

The computer simulation was given to the ophthalmologist who gives the lectures covering glaucoma and other conditions of the eye at the University of Arizona (UA) College of Pharmacy. He ran the program a number of times and gave very positive feedback on the technical and therapeutic correctness of the material presented within it. This served as an acceptable validation mechanism for the program.

The resulting program was then distributed to students enrolled in PhPr 475c (Pathophysiology and Pharmacotherapeutics) Course. The course coordinator randomized the 48 students to receive either the computer simulation or a written case study that had been used in previous years for this course covering the same topic. During the designated discussion period, all students were given a quiz covering the glaucoma material (Appendix A). An independent *t*-test. was performed on the two means (computer simulation versus control) at the 0.05 level of significance to detect any

Pilocarpine response command 1

COMMAND Return Any

FlagOff2	Universal nonresponder
FlagOff50	SOME PILO IS effective
FlagOn69	No beta-blocker effects
VariableGT 3 21	Current IOP is not 21 so max response not reached yet
Subtract From	
Variable 3 2	Auto response (takes 2 off current IOP)
Chance 15	15% chance of greater response
Subtract From	
Variable 3 1	Takes another point off IOP
Turn FlagOn 1 9	Will skip commands that add to IOP
End_Command	

Sample command format. This calculates a patient response to pilocarpine based on use of other agents, patient's current IOP, and chance for maximum response.

Fig. 2. Sample command format.

differences between the performance of the two groups. A subsequent test for effect and a power analysis were also done.

RESULTS

The mean for the computer group was found to be 8.21 (out of 11 possible) with a standard deviation of 1.21. The mean for the control group was 7.83 ± 1.93. The f-test showed that there were no significant differences between the two groups on quiz performance. A subsequent calculation for effect size showed that there was a small effect (0.31). Based on the results of this study, a power analysis was performed. It was determined that at least 116 subjects would need to be enrolled to demonstrate a significant difference (one point out of 11 possible) in favor of the computer group at alpha = 0.05 and beta = 0.20.

DISCUSSION

This program had some limitations due to the software program employed and the lack of programming experience of its authors. The biggest limitation was lack of user-friendliness. The program was distributed along with an instruction booklet for the students, but most students voiced the complaint that the program was confusing the first few times through. However, it was also stated that if more programs like this one were given to them on a periodic basis, they would quickly become proficient in the technicalities of running them. Improvements that were suggested both by the authors of the program as well as from program users include: adding a graphics capability, modifying the software so that it could be run through Windows, and adding more dramatic scenarios to reinforce the major tenets of therapy (*e.g.*, do not give timolol to patients with asthma).

Even with the limitations of the program as stated above, this study found results that were similar to those found by Hurst *et al.*(4) with their cardiology simulations. These computer programs have the advantage of allowing students to solidify their knowledge of a particular disease state and gain experience in "treating" a patient without experiencing the real life consequences that can occur if a live patient was the subject of study. It is hoped that further development and validation in this area of pharmacy education will continue providing pharmacy educators with more

DM returns to clinic for f/u as you requested. Intraocular pressure: 26 mmHg.

Patient complains of nearsightedness and decreasing night vision with his pilocarpine use. His wife has to drive if they go anywhere at night.

Q: If a patient is using 2 or more types of eye drops, he/she should wait about 5 to 10 minutes between applications of them. True or false?
Student: T

What now? Add Betaxolol 0.5%

How many times per day do you
want the patient to use Betaxolol? BID

What now? Return to clinic

In how many weeks? 3

DM returns to clinic for f/u as your requested. IOP 26 mmHg. Patient complains of eye pain on instillation of pilocarpine. It is about a 3 or 4 on a scale of 1 to 10.

Sample interaction from simulation. Student answers a question before deciding what to do next. Patient returns to clinic after starting betaxolol and, in this case, has no added response.

Fig. 3. Sample interaction from simulation.

options to augment their curricula and improve the practical and problem-solving skills of their students.

CONCLUSIONS

At this time, the program authors are exploring the possibility of converting the program to a Windows-compatible format, and there are discussions of future development of similar programs covering different disease states. The ultimate goal would be to create a program that could present a patient with either a single disease state for learning reinforcement or with multiple disease states to reinforce integration of knowledge. However, a new data base program would have to be used to overcome the limitations encountered with AGT. These future programs will take a considerable amount of time and effort to create but could ultimately provide a very useful adjunct to reinforcement of classroom learning.

A computer simulation for a patient with open-angle glaucoma was developed and tested in a pharmacotherapeutics course. The results of this study showed no significant differences in test scores between the computer group and the control group. It was concluded that computer-assisted instruction is as effective as traditional written case presentations in augmenting information received in lecture. Further developments in this area will provide both pharmacy educators and students with valuable learning tools that should benefit them in future practice.

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APPENDIX A.

Glaucoma Quiz

(This is for data analysis ONLY. No grade will be assigned.)

Patient M.R. is a 55 YOM who has been treated for OAG with Pilocarpine 4%, 1 gtt ou qid for 6 months. M.R.'s current IOP is 25R/25L. The rest of M.R.'s PMH is noncontributory. No other medications have been tried.

1. Which of the following would be reasonable options for M.R.'s therapy? (circle all that apply)
   a. continue with current regimen because patient hasn't been on it long enough to see full effect
   b. increase strength of pilocarpine to 6%, 1 gtt ou qid
   c. add timolol 0.5%, 1 gtt ou bid
   d. D/C pilocarpine and start epinephrine 1 %, 1 gtt ou qid
2. If M.R. were to start using combination therapy, how would you tell him to use his eye drops, (choose the best statement)
   a. use the first drug and then use the second drug immediately afterwards for best effect
   b. spread out the application of the two drugs by at least 30 minutes to one hour for best absorption
   c. space the application of the two drugs five minutes apart for best absorption
3. A patient taking pilocarpine 2% (1 gtt ou qid) for two days comes to you complaining of a stinging sensation and a browache upon instillation of her eye drops. Which of the following is the best course of action?
   a. D/C the pilocarpine immediately and give her sulfacetamide 10% for possible eye infection
   b. tell the patient that this is a common side effect and that she will develop tolerance to it with continued use
   c. tell the patient to use 2 gtts ou bid instead
4. One of the more serious side effects of the cholinesterase-inhibiting glaucoma agents is retinal detachment.
   a. true b. false
5. Beta-blockers or pilocarpine are generally used as initial therapy in OAG because of their good efficacy and lower incidence of side effects as compared to other glaucoma agents.
   a. true b. false
6. In a patient with newly diagnosed OAG, an appropriate initial medication regimen would be:
   a. pilocarpine 6% 1 gtt ou qid c. betaxolol 0.5% 1 gtt ou bid
   b. epinephrine 1% 1 gtt ou tid
7. A relative contraindication for timolol therapy is a patient with asthma.
   a. true b. false
8. A relative contraindication for pilocarpine therapy is a patient with diabetes.
   a. true b. false
9. In a patient whose IOP is not controlled with a regimen of betaxolol 0.5% (1 gtt ou bid) and pilocarpine 6% (1 gtt ou qid), an appropriate course of action would be:
   a. add carbachol to the regimen
   b. add timolol to the regimen
   c. add dipivefrin to the regimen
   d. a or c is appropriate
   e. any of the above is appropriate
10. In a patient who continues to have visual field losses and/or optic disk changes on follow-up exams even when IOP is controlled, it is reasonable to consider a surgical option,
    a. true b. false

11 points possible (question 1 has two answers)