Development and Evaluation of a Computer-Assisted Instructional Program in An Advanced Pharmacotherapeutics Course[1]

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The manuscript describes the development, implementation, and evaluation of a computer- assisted instructional (CAI) program to facilitate learning in an advanced pharmacotherapy course taught to Doctor of Pharmacy students. The target disease states for this pilot program were peptic ulcer disease (PUD) and gastroesophageal reflux disease (GERD). Objectives included: (*i*) developing a CAI program for the therapeutic management and pathophysiology of PUD and GERD; and (*ii*) determining the acceptance of the PUD/GERD CAI program as a method of teaching pharmacotherapeutic principles. All University of Georgia Pharm. D. students enrolled in the Fall 1995 Advanced Pharmacotherapeutics course were invited to use the CAI program after four hours of PUD/GERD lectures. Students completed a survey upon completion of the PUD/GERD CAI program. This survey evaluated students' acceptance and perceptions of the effectiveness of the PUD/GERD CAI software as an instructional instrument. Results indicated that students (n=40; 100 percent of the class) perceived that the PUD/GERD CAI program was a valuable learning experience (4.20 ± 0.60; Likert scale: 1 = "strongly disagree" to 5 = "strongly agree") and felt it enhanced patient-problem solving skills (3.96 ± 0.87). In addition, students expressed the desire to use CAI programs for other pharmacotherapeutics topics (4.45± 0.63). Although students enjoyed using the PUD/GERD CAI program (4.28 ± 0.65), they disagreed with the statement that the CAI program should be used in place of traditional pharmacotherapeutics lectures (1.75 ± 0.70) and favorably indicated that it should be used as a supplement to lectures (4.55 ± 0.67, $P<0.01$). Computer-assisted teaching in combination with traditional pharmacotherapeutics lectures is valuable in the instruction of pharmacotherapeutics.

INTRODUCTION

Development of patient-focused care and patient-problem solving skills is crucial for pharmacy education'. Pharmacists must have the skills to integrate prior knowledge with facts, concepts, and principles to make appropriate decisions regarding patient outcomes(1,2). The traditional lecture format of classroom instruction, although efficient and effective when the primary goal is dissemination of information, should no longer be considered the only method of instruction. Today, educators have many educational tools available which include computers, videos, and the delivery/ reception of educational programs by distance learning. Under such conditions the traditional lecture format, while a well-established mainstay of professional education, mainstay of professional education, may not be the only component of didactic education. Instructional methods that permit students to cntrol the time, pace, and assessment of their own learning experience are in demand.

To facilitate competent clinical decision-making, students must be given opportunities to practice solving problems in an authentic environment(3). Ideally, pharmacotherapeutics instructors would take each student to the bedside of patients while teaching each disease state or therapeutic problem. Given the practical impossibility of accomplishing this, educators seek to develop alternatives which provide realistic case experiences. Computers, with more versatile authoring software, enhanced speed and graphics capabilities, are considered an increasingly appropriate instructional device.

Computer technology is neither new to education in general nor pharmacy education in particular. In a comprehensive, interdisciplinary review of the literature on the effects of computer-enhanced instruction, Clark found that when learning efficiency and student preferences are variables of interest, well designed self-paced computer-assisted learning programs consistently outperform traditional methods of instruction such as lectures(4). In pharmacy education, studies examining the effectiveness of CAI have suggested that it is comparable in effectiveness to other teaching methods(5,6). Pharmacy educators have also studied the impact of CAI on students" grades. Clem and colleagues demonstrated that there was no significant difference in examination scores between students who used CAI programs to learn material on a clinical psychopharmacy clerkship versus students who received traditional lectures to learn the material(7). In 1995, Kinkade and others found that their computer simulation program was as effective as their paper case presentations and recommended that further research be done to investigate the utility of employing other instructional methods in teaching therapeutics(8).

Although the use of computers in pharmacokinetics, dispensing, pharmaceutical calculations, and pharmacology is well described in the literature(6,9-15), studies describing the use of computers to enhance clinical decision-making among pharmacy students are limited (8,16-18). A comprehensive literature review from 1976 to 1996 yielded few studies in pharmacy education that focused on students' attitudes toward CAI(12,19,20), and even fewer studies that focused on pharmacy students' attitudes toward using CAI to facilitate the development of clinical decision-making skills(18).

This study evaluated students' attitudes toward a CAI program developed by the investigators to facilitate prob-

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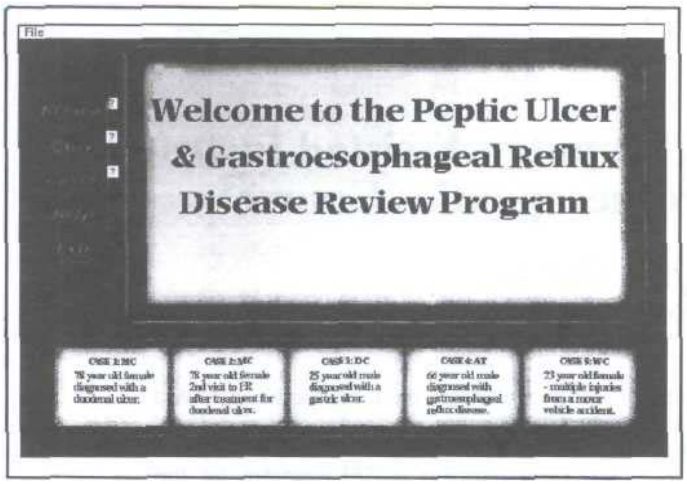

Fig. 1. Main menu of PUD/GERD CAI program.

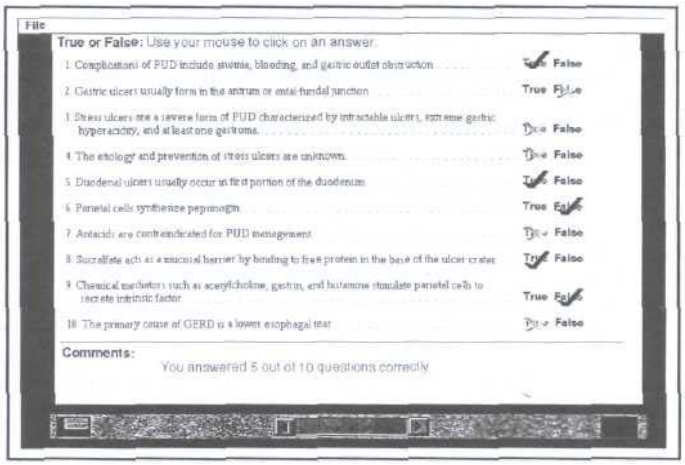

Fig. 2. By using the computer mouse, student answered each question by clicking on either "True" or "False". The PUD/GERD CAI evaluates each response and indicates whether the response is correct [✓] or incorrect [✗]. After answering all the questions, the student's score is displayed in the comment section.

lem solving skills in an Advanced Pharmacotherapeutics I course (PHR 587). The target disease states for this pilot program were peptic ulcer disease (PUD) and gastroesophageal reflux disease (GERD). Objectives of the study were to: (*i*) determine the acceptance of the PUD/GERD CAI program as a method of teaching pharmacotherapeutic principles; and (*ii*) determine if students prefer to learn pharmacotherapeutics by CAI or by the combination of CAI and traditional pharmacotherapeutics lectures.

DESCRIPTION OF ADVANCED PHARMACOTHERAPEUTICS I

Advanced Pharmacotherapeutics I (PHR 587) is a required course in the Doctor of Pharmacy (PharmD) curriculum at The University of Georgia College of Pharmacy (The College of Pharmacy). Advanced Pharmacotherapeutics I is the first pharmacotherapeutics course in a series of three that is taught to PharmD students at The College of Pharmacy. This six-hour quarter course focuses primarily on the pathophysiology and management (pharmacological and nonpharmacological) of disease states.

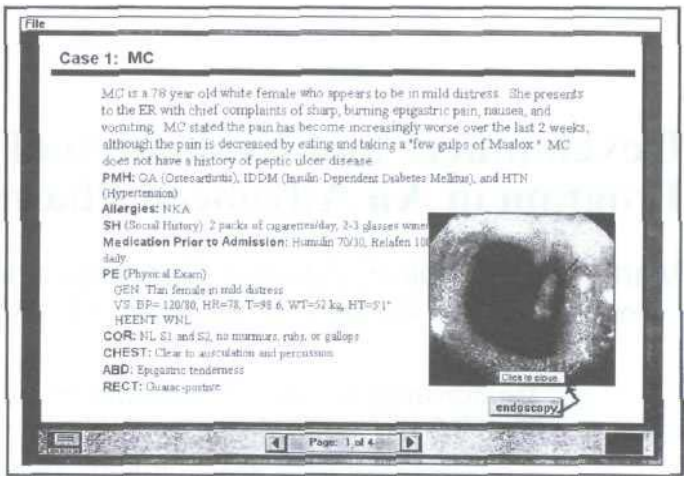

Fig. 3. Description of patient (Case 1), including patient's endoscopy.

DESCRIPTION AND RESULTS OF A PILOT PROJECT CONDUCTED IN THE ADVANCED PHARMACOTHERAPEUTICS I COURSE

To identify ways to enhance the development of patient-problem solving skills of PharmD students, a survey was conducted involving third-year PharmD students in the Fall of 1994. Results indicated that students perceived a need for the presentation of more patient case studies during lectures. At best, it is only possible to review factual information and present a few briefcase studies during the allotted lecture time. The investigators of this study believed that the combination of lectures and computer-aided instruction would meet students' requirement for additional case material. However, the acceptance and the utility of CAI in the Advanced Pharmacotherapeutics I course by students were unknown. To test the value of combining CAI and traditional lectures in Advanced Pharmacotherapeutics I, a computer program for one course unit was developed, implemented, and evaluated. The course unit selected was the PUD/GERD module.

DESCRIPTION OF THE PUD/GERD CAI PROGRAM

A CAI module on PUD/GERD was developed by the authors using the course design software Authorware 2.0 for Windows. The course included three instructional environments which students could access from a perpetually available main menu (Figure 1). A review section presented an overview of PUD/GERD in a straightforward text format supported by graphics. A quiz allowed students to test their understanding of basic PUD/GERD concepts and medication dosing before attempting the case studies (Figure 2). The CAI was developed to closely match the content, presentation, and objectives of the PUD/GERD lectures.

The core of the module was five case studies, each addressing a common PUD or GERD patient presentation. Cases were structured to parallel typical class case presentations in terms of case scenarios, access to information, and case questions. Each case consisted of a color photograph of the fictional patient, case history including patient data, chief complaint, history of present illness, past medical history, medical and family history, laboratory data, and diagnostic photographs (Figure 3). A series of questions, in a variety of question types (short answer, fill in the blank. multiple choice, matching, and true/false), probed students' understanding of each patient's clinical pharmacotherapeu-

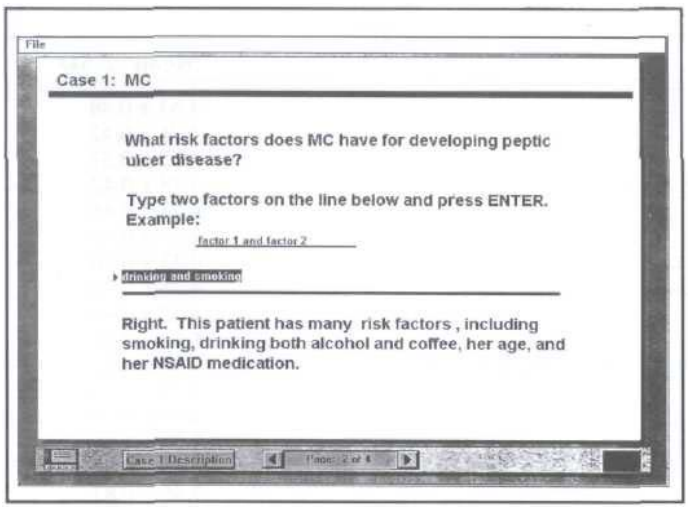

Fig. 4. CAI Program evaluates student's response to question and indicates appropriateness.

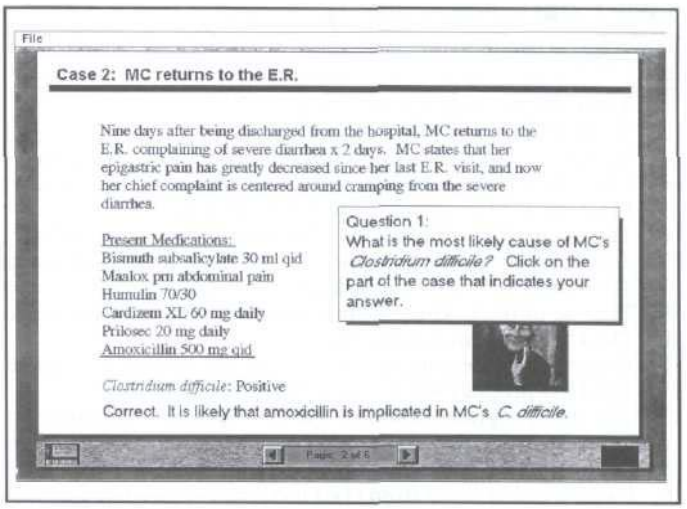

Fig. 5. By using the computer mouse, student clicked on Amoxicillin 500 mg qid. CAI Program evaluates response.

tic situation. Questions focused on identifying, treating, and solving patient-specific problems (Figures 4 and 5) . and provided students with immediate feedback on their performance. For each short answer and fill-in-the- blank question, a comprehensive set of correct and incorrect key terms was developed through formative evaluation. Students' responses to questions were matched against these key terms to determine appropriate feedback (*i.e.* correct, incorrect).

The CAI module was developed and revised by the instructors over a five month period and involved approximately 300 hours of time between a clinical assistant professor of pharmacy practice, a gastroenterologist, and an instructional designer/programmer. The final pilot PUD/GERD CAI program that was used by the students in this study represented approximately 60 minutes of computer instruction.

The final version of the PUD/GERD CAI program was loaded on four computers in the pharmacy students' computer center on campus. Since the CAI program was loaded only on computers in the computer center, the center was open beyond normal hours for a total of seven school days.

METHODOLOGY

All University of Georgia College of Pharmacy PharmD students enrolled in the Fall 1995 Advanced Pharmacotherapeutics I course (n=40) were invited to use the PUD/GERD CAI program after receiving four hours of PUD/GERD lectures. Students were asked to complete a survey after using the PUD/GERD CAI program. This survey evaluated students' acceptance and perceptions of the effectiveness of the PUD/GERD CAI software (see Table I for survey questions). Investigators of the study were blinded to the identity of the student respondents. On a five-point Likert-type scale (ranging from 1= "strongly disagree" to 5= "strongly agree"), students were asked to indicate their response to 28 statements about the PUD/GERD CAI.

Data were entered in a computer database and analyzed using SPSS for Windows (Release 6.1). The Cronbach's alpha test was used to assess the reliability of the survey instrument. Frequencies and descriptive statistics such as means and standard deviations for each question on the survey were calculated. The Mann-Whitney U Test was performed on the nonparametric data to determine if students preferred that the CAI program be used in place of lecture or used to supplement lecture. The alpha priori level of significance was 0.05.

RESULTS

Forty students participated in the study (100 percent of the class). The study group consisted of 26 females and 14 males. The mean age was 25.2 (SD=4.70). Thirty-four of the students were tracking PharmD students and the remaining six were post-BS PharmD students. The reliability coefficient of the survey instrument is 0.84 (28 items). The means and standard deviations for each survey item are displayed in Table I. Overall, students indicated that they perceived that the PUD/GERD CAI program was a valuable learning experience (4.20, SD=0.60) and felt it enhanced patient-problem solving skills (3.96, SD=0.87). In addition, students expressed that the CAI program facilitated learning (4.73, SD=0.45) and that they desire to use CAI programs for other pharmacotherapeutics topics (4.45, SD= 0.63). Although students enjoyed using the PUD/GERD CAI program (4.28, SD= 0.65), they disagreed with the statement that the CAI program should be used in place of pharmacotherapeutics lectures and favorably indicated that it should be used as a supplement to lectures (1.75, SD=0.70; 4.55, SD=0.67, $P<0.01$).

DISCUSSION

The objective of this study was to assess students' perceptions of the utility of the PUD/GERD CAI program as an instructional tool. Results revealed that students perceived the CAI program as a valuable learning experience (4.20, SD=0.60) and, importantly, they believed that it enhanced their pharmacotherapeutic problem solving skills (3.96, SD=0.87). In addition, the results suggest that our students view CAI as a viable supplement to traditional pharmacotherapeutics lectures, thus confirming the merit of this instructional method as an important tool for enhancing pharmaceutical education.

A goal in designing the computer module was to provide both a comprehensive PUD/GERD review and challenging cases for student self-study which did not require access to the instructor for feedback. Students were not only

Table I. CAI program survey scores

Question	Mean[a] ± SD
1. The CAI program was easy to use.	4.63 ± 0.48
2. The CAI program was well organized.	4.76 ± 0.42
3. Sufficient instructions were included in the CAI program.	4.65 ± 0.57
4. I feel the CAI program reinforced the material that was covered in class.	4.78 ± 0.42
5. I feel the CAI program facilitated learning.	4.73 ± 0.45
6. The material covered in the CAI program was appropriate.	4.58 ± 0.63
7. The number of cases presented in the CAI program was appropriate.	4.33 ± 0.76
8. The number of questions asked in the CAI program was appropriate.	4.28 ± 0.74
9. The use of the CAI program was convenient and easy to access.	4.32 ± 0.85
10. The CAI program was boring.	1.68 ± 0.65
11. A computer (computer program) can never match the human contact that a teacher provides.	3.60 ± 1.11
12. The CAI program should be used in place of lectures.	1.75 ± 0.70
13. The CAI program should be used to supplement lectures.	4.55 ± 0.67
14. Learning from a computer is a cold and impersonal experience.	2.30 ± 1.05
15. Learning from a computer is an exciting way to learn.	3.43 ± 0.83
16. I would rather learn from class lectures than a computer program.	3.96 ± 0.87
17. I like the combination of both lectures and computer instruction.	4.52 ± 0.55
18. I feel the CAI program has helped me develop my patient problem solving skills.	3.96 ± 0.87
19. I would like to use similar CAI programs for other lectures.	4.45 ± 0.63
20. I feel that the computer learning exercise (CAI program) should be mandatory for all student in therapeutics.	3.02 ± 1.08
21. The graphical illustrations in the CAI program were appropriate.	4.52 ± 0.55
22. The graphical illustrations in the CAI program were informational and facilitated learning.	4.48 ± 0.55
23. The CAI program helped me apply my knowledge.	4.25 ± 0.58
24. I learned a lot from the computer program.	4.03 ± 0.52
25. 1 think the CAI program was helpful in preparing me for the test.	3.87 ± 0.69
26. My overall impression of the CAI program was that it was useful.	4.33 ± 0.52
27. Overall, the CAI program was a valuable learning experience for me.	4.20 ± 0.60
28. I enjoyed using the CAI program to enhance my patient problem solving skills.	4.28 ± 0.65

[a]Scale: 5=Strongly Agree; 4=Agree; 3=Neutral; 2=Disagree; 1=Strongly Disagree.

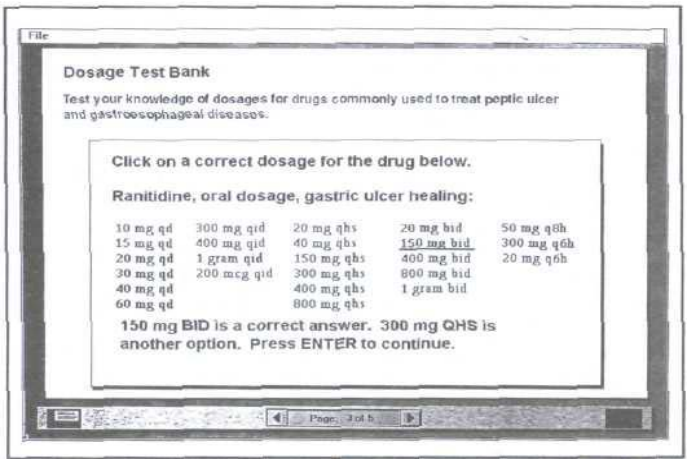

Fig. 6. By using the computer mouse, the student answered the question by clicking on 150 mg BID.

challenged to provide the correct responses to questions but to understand why their responses were correct or incorrect. Although access to the instructor was not denied, students were encouraged to investigate the answers to questions themselves prior to seeking aid from the instructor.

Since the "Review" and "'Quiz" portions of the module duplicated the conceptual material covered in the classroom PUD/GERD lectures, students could have reasonably suggested it as an alternative to class lectures; instead they strongly viewed the role of the CAI program as a supplement to (4.55, SD=0.67), and not a replacement for lectures (1.75, SD=0.70). Results of the study suggest that students are not opposed to the use of computers in their education but appeared unwilling to relinquish face-to-face instructor-student contact. This finding, an area for further study, may be specific to this student population, or it may represent a general pharmacy student preference and thus have important cautionary implications for large-scale CAI implementations without the involvement of instructor- student interaction.

Similar to the students, the Advanced Pharmacotherapeutics instructor perceived the PUD/GERD CAI software as an important adjunct lo lecture. For the instructor, although it took approximately 300 hours initially to develop, the CAI provided time management benefits. The instructor's personal observations were that, when compared with previous years, less lecture time was required to cover medications (*e.g.*, PUD/GERD medication dosing, which was covered in a drill-and-practice format in the CAI program- Figure 6) and the recovered lecture time allowed for the addition of three patient care scenarios (case studies). Thus, the CAI program supported the instructor's efforts to direct class time toward facilitating critical thinking and problem-solving skills.

Like the students, the instructor believed that the CAI program should not be used in place of the PUD/GERD lectures but as a supplement to the lectures. Overall, the instructor concurred with Clem, that the use of CAI was a motivational and convenient instructional tool in teaching pharmacy students(7).

CONCLUSIONS

The study results suggest that the use of a CAI in an advanced pharmacotherapeutics course is perceived by students as a valuable instructional tool, a desirable adjunct to lecture, and a useful forum for developing patient problem-

solving skills. The results indicate that, while students enjoyed learning with the CAI program, they disagreed with the statement that the CAI program should be used in place of traditional pharmacotherapeutics lectures and favorably indicated its use as a supplement to lectures. Students prefer the "human touch" of an instructor in their education.

The use of computers in the educational system is growing rapidly. Utilization of large scale CAI is likely to increase to meet the educational demands created by the conversion to an entry level PharmD curriculum, implementation of nontraditional PharmD programs, proliferation of medical knowledge, and limitation of lecture time. Although the results generated from this study are limited to the study population and institution, they represent a starting point for future development, implementation, and evaluation of CAI programs that enhance pharmacotherapeutic problem-solving skills.

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