INNOVATIONS IN TEACHING

Adaptive and Longitudinal Pharmaceutical Care Instruction Using an Interactive Voice Response/Text-to-Speech System

Gamal Hussein, PharmD and Nancy Kawahara, PharmD, MSEd
School of Pharmacy, Loma Linda University

Objectives. To develop a course structure that would more closely simulate the actual provision of pharmaceutical care.

Design. An interactive voice response/text-to-speech system (hardware and software) for obtaining patient data was designed and used in a pharmaceutical care laboratory. Students called the system to collect data, listen to progress notes, make recommendations, and update the pharmaceutical care plan for virtual patients. Laboratory time was utilized to evaluate patient progress and respond to recommendations as well as to identify and solve drug-related problems.

Assessment. Students’ recorded communications with the system and completed care plans were evaluated and a competency-based final examination was administered. Peer evaluations and course evaluations were administered.

Conclusion. This innovative approach challenged students and promoted interactive learning. Student evaluations indicated we achieved our objective of creating a course that more closely simulated the actual provision of pharmaceutical care.

Keywords: pharmaceutical care, interactive voice response system, text-to-speech system

INTRODUCTION

Pharmaceutical care laboratory (PCL) courses offer students the opportunity to learn and practice pharmaceutical care skills in a controlled environment. These courses usually include instruction in dispensing as well as clinical activities. In most colleges and schools of pharmacy students are provided with a written patient case or the information is posted on the Web. Laboratory time is used to discuss issues related to patient assessment and modification required in drug therapy. Typically, a new patient case is presented in each laboratory section and no “follow up” care of patients from previous laboratory sections is discussed. Thus, the longitudinal approach to patient care is not applied. Students do not experience the “what then” scenario following their recommendation. Cases are commonly focused on 1 or 2 disease states and all relevant information is provided to students. In real practice, patient care is commonly a more complex process that is complicated by many disease states and data collection is required. Patient charts and hospital databases typically contain massive amounts of data and pharmacists need to discriminate and make appropriate decisions regarding which data are required for drug therapy assessment and the decision-making processes. Pharmacists follow individual patient responses, which often vary and may not be what is expected. Few drug therapy problems can be corrected in one visit, and new complications or errors may be encountered with each subsequent hospital day or clinic visit. For example, on hospital day or visit 1, empiric antibiotic therapy may be provided to a patient with a suspected infection. In visit 2, this therapy may need modification based on the results of laboratory culture and drug sensitivity. In visit 3, the antibiotic dosage may need to be altered based on drug plasma concentration or patient response. In visit 4, an adverse event may be encountered and an investigation may reveal an error in drug administration or suboptimal management of another disease state.

In order to prepare students for the reality of patient care, a longitudinal approach involving complex cases is recommended. One means of accomplishing this is to create a scenario in which the patient’s condition changes with every visit. These changes in patient response to care may be related to the student’s drug therapy recommendation, a disease complication, or deterioration in organ function. Changes commonly require reevaluation of current therapy, dosage modifications, or ordering laboratory tests. We have designed a course that provides students with pharmaceutical care experience that is as close as

Corresponding Author: Gamal Hussein, PharmD, Loma Linda University School of Pharmacy, 11262 Campus Street, West Hall 1331, Loma Linda, California 92350. E-mail: ghussein@llu.edu
possible to actual practice. Based on over 40 years of combined hospital and teaching experience, the authors have created several virtual patients whose responses to care vary based on students’ input and recommendations. For example, if a wrong drug or dose is recommended, an adverse event may occur; if patient counseling is not provided, an error in administration may be encountered; if patient compliance is not evaluated; drug levels may be unexpectedly altered; if an abnormal laboratory value such as elevated potassium, glucose, or lipoproteins is not addressed and corrected, complications may be encountered. The application of virtual patients who change in ways appropriate to the recommendations students make creates scenarios that more closely parallel the reality of pharmaceutical care. Since students must search online databases and study other resources to gather the information needed to make informed decisions about their patients, the course also builds the data collection skills they will need in actual practice.

These innovations are made possible by using an interactive voice response system (IVR) and a text-to-speech (TTS) system. The IVR system is commonly described as a talking computer connected to a telephone line, which can be accessed via a touchtone telephone. Computer telephony is the term commonly used by programmers. TTS is the ability for a computer to read written text instead of playing prerecorded voice files. Voice files require larger computer storage space compared to text files. TTS capability is optimal for communicating large amounts of data, especially when menus of available data/information are generated in response to user input or selection.

Telephony applications offer advantages over Web-based programs. Data on Web sites may only be retrieved via a computer, while telephony data may be obtained via telephone. Telephones are more accessible and more widely used than computers. The alternative Internet voice technology of reading web pages and Internet contents are not as well developed as telephony.

IVR systems are used to retrieve information from databases and read it to callers. These systems are widely utilized by banks for account information, business for order information, marketing companies for surveys and product promotion, and the US government for many applications such as tax filling. Recently the use of these systems in healthcare has been evaluated. These systems have been utilized for patient education, patient monitoring, disease state management, patient compliance, and patient appointment reminder systems. Experimentation of these systems in education has been limited to assessment of student understanding of topics and mastery of material. To our knowledge, these systems have not been utilized or tested for curricular-based teaching. Our intent was to develop a new technology and adaptive approach for the teaching of pharmaceutical care laboratories.

The goals of the innovation were:

1. To build an IVR-TTS system (hardware) and develop a computer program (software) tailored to administering a pharmaceutical care laboratory.

2. To design and implement a challenging, interactive, adaptive teaching methodology and assessment process to be used along with the IVR-TTS system.

3. To objectively evaluate the use of the IVR-TTS system and the methodology based on learning objectives and desired outcomes.

The software mentioned in the first objective is a telephony application that communicates any text to the user over the telephone with high quality, multi-tone voice capability. The completed software was capable of designing submenus “on the fly” from the available contents (index) of a large database of user choices. In addition, the user can quickly retrieve a topic by entering the topic number. We designed the system and tested its capability before implementing it. During the testing stages in 2003-2004, the performance and quality of the voice was deemed acceptable by faculty members and students.

The adaptive approach described in objective 2 was developed to allow students to observe the results of their actions and recommendations. Students interacted with the system to collect patient data, communicate recommendations, and follow up on patient responses.

**DESIGN**

The *Pharmaceutical Care Laboratory* is a course designed to challenge students to apply classroom pharmaceutical knowledge and ability at increasingly higher levels of sophistication. The students are introduced to the whole patient approach by focusing on therapeutic drug monitoring and pharmaceutical care planning. Students are trained to collect patient data and perform patient assessment in a systematic way. Students practice establishing follow-up plans for continuously assessing patients and enhancing their pharmaceutical care. Each student, as a part of a working group, is assigned a set of patients and is required to continuously (1) collect patient data (via an interactive voice response system); (2) critically evaluate data and patient response to identify drug-related problems; and (3) make recommendations (via an interactive voice response system) to optimize therapy and patient outcomes. Throughout the course, students are provided opportunities to examine issues such as improper drug
therapy (drug and dosage selection), adverse drug events (reactions, errors, and noncompliance), and monitoring/response issues (ie, improper monitoring or unacceptable response). Developing a comprehensive and longitudinal pharmaceutical care plan is practiced on a continuous basis throughout the course. Independent study, literature searching, and critical thinking are integral parts of this course.

Learning objectives and desired outcomes of this innovation are those of the Pharmaceutical Care Laboratory. Students are expected to:

1. Collect patient data, ie, medication/disease history, family and social history, chief complaint, progress notes, laboratory and diagnostic tests, and response to therapy.
2. Critically examine patient data and utilize the medical literature to identify drug related problems.
3. Set goals and design/implement a comprehensive/longitudinal pharmaceutical care plan with adequate follow-up in order to optimize therapy.

The system was utilized by third-year pharmacy students during the fall of 2004. Students at this level have completed several integrative pharmacology, pathology, and therapeutics modules. The class was divided into 2 sections, with 17 students assigned to each. Each section included 4 groups (4 students each) and a student acting as a system manager for that section. Each group was assigned 4 patients and the 4 students worked together to provide quality patient care. However, each student in the group was the care coordinator for 1 patient. The care coordinator was responsible for final decisions regarding patient care issues. The system manager was assigned to a group, but their main responsibility was to help the entire section with drug information resources and answers to common questions. The system managers also posted weekly prayers, quotes, and links to beneficial web sites.

One of the students’ primary responsibilities was ongoing communication with the IVR-TTS system. Students were required to call a telephone number (2-4 times a week) to listen to patient information/progress notes as well as to leave medical/laboratory orders. Patient profiles were only provided during the first visit. Students were required to update the active profile at each subsequent visit.

A 2-hour lecture each week focused on topics and controversies related to the assigned patients. Sample topics included management of acute tubular necrosis (drug dosage adjustment and when to start dialysis), recognition of adverse drug events (different types of errors and reactions), management of a difficult patient, and identifying noncompliance in a specific patient. The instructor’s responsibility focused on addressing related issues and moderating class discussion. Handouts were used and relevant treatment guidelines were discussed. Students’ responsibility focused on discussing presented topics and controversies as they related to their patients. Sample topics included management of hypertension in a selected population and cost comparison of oral hypoglycemic agents.

A 3-hour laboratory period per section per week focused on patient assessment and literature searching as well as the decision-making process. The instructor’s responsibility focused on helping each group with their patient assessment and decision-making processes. The instructor spent an average of 40 minutes with each group. The remaining time was utilized for student presentations during which the instructor moderated the discussion. Students’ responsibilities during the laboratory period focused on patient assessment, literature searching, and decision-making processes. Each group was required to get data updates from the IVR-TTS system before coming to the laboratory. During the laboratory, the group discussed their patient, performed medical searches, agreed on recommendations, and made a presentation in a grand rounds format. Each group had a notebook computer equipped with a wireless connection to library databases, the Internet, and the course web site. Students worked together to complete the pharmaceutical care plans and were required to e-mail the plans to the instructor by the end of the 3-hour laboratory, as well as leave voice messages for the instructor with any medical/laboratory orders or questions. Students updated the document for each patient on a weekly basis as opposed to creating a new document every week. Each group had 4 patient assessment and care plans (one form for each patient) that were updated each week for an 8-week period.

The length of the course was 10 weeks. The first week included introduction to the process and technology as well as discussion of the course syllabus and expected competencies. The second week was utilized by students and the instructor as a practice session using a sample patient scenario. Weeks 3 through 10 were utilized for conducting actual patient care activities for the assigned virtual patients so that each patient was “visited” 8 times. Each virtual visit represented a hospital day or a clinic visit at which new patient data were available. Patient 1 for each group had an almost identical disease presentation, complications, history, medication profile, and demographics. However, the patients started to deviate over time according to each group’s input and recommendations. Some patients improved, some experienced adverse
events, and others had additional complications in response to the students’ initial recommendations. The following is a sample of a patient care scenario that took place with patient 1:

The patient was admitted with a GI bleed (that was corrected with surgery), diabetes, chronic heart failure, and uncontrolled hypertension. Complications of surgery included acute tubular necrosis that required management and dosage adjustment of medications. Self-initiated nonprescription medications were also interfering with drug therapy. The nurse failed to administer 3 doses of digoxin (a medication error that complicated the interpretation of digoxin levels). The patient later developed hospital-acquired pneumonia and empiric antibiotic therapy was initiated. Antibiotic therapy was changed based on culture and sensitivity and gentamicin dosage modification was required. Interpretation of laboratory values and medical terminology were also encountered.

Initially, patient variation among groups was minimal. This was done to assure a similar baseline for all groups. Instructors evaluated students’ recommendations on a weekly basis and formulated patient’s response. The response was typed into the system to be read to students during the follow-up. The patient’s response was dependent on the student’s recommendation, ie, proper recommendations led to patient improvement while improper recommendations led to patient deterioration. Consistency was assured so that the same recommendation by different student groups resulted in a similar response.

Since the IVR-TTS system was only accessible to 1 student at a time, a backup system was essential. However, we did not want to provide a handout to students. For this reason, we designed a web page with a genie character that read the same patient data to students that were available via the IVR-TTS system. The text disappeared after the genie finished speaking; thus, preventing students from using the computer’s copy/paste text function. This was done to enhance students’ listening skills in coordination with the visual cue. It is our experience that students frequent use of the cut/paste function minimizes their processing and comprehension of materials.

The final examination for the course was designed to address decisions made by students and ask for further explanations. The final examination also addressed issues that were not discussed in laboratory but were expected to be researched by the student groups. For these reasons, students received a copy of their completed care plan along with the final examination. The test was designed to direct students to components in the care plan they created and a course competency that each question address. We initially thought that we may have to write a separate examination for each student group. However, while patients varied, it was possible to compose questions that applied to all patients. Of course, the correct answer to the question might vary.

**ASSESSMENT**

During the first week of the course, students spent an average of 2 minutes to leave a message with medical and laboratory orders, while the average time during week 8 was 15 seconds. Students’ spoke with more confidence and left more concise and clear requests later in the semester. The instructors also felt that students’ patient presentations were more organized and issues of concern were more appropriately prioritized toward the end of the semester.

Given that this was the first time this course was taught, we did not have baseline data with which to compare this student cohort. However, the longitudinal design of the course did allow us to compare the first care plans that students submitted with the final care plans submitted at the conclusion of the course. The patient assessment and care plan template that was provided to students guided the students through the data collection, patient assessment, and care planning processes. The document prompted students to collect needed information, provided hints to guide their assessment of drug therapy, and gave them a structure to assist them in pulling the entire process together into a pharmaceutical care plan.

In the beginning, nearly all student groups missed important points in the data collection process. They frequently failed to provide dates for the data collection which made it difficult for them to appropriately evaluate drug levels. Despite being prompted by the form to assess whether medications the patient was receiving were the drugs of choice for the medical conditions, many of the groups skipped over this aspect of the process, making their assessment incomplete. The form also prompted them to assess dosing for appropriateness and to gather necessary information to evaluate the patient’s renal and hepatic function. In order to appropriately assess the dosing, students were required to consider the patient’s renal and hepatic function along with how the drug was cleared from the body. In the beginning of the quarter, students simply compared the stated dose with a drug reference to determine whether the dosing was in line with the usual adult dosing guidelines. They failed to coordinate the pieces of information necessary to make a patient-specific assessment.

In the final patient assessment and care plan, dates for the data collection were rarely left blank, and this additional data allowed students to make more informed
decisions regarding drug levels. The final documents always included a determination of whether each medication was the drug of choice for the patient’s medical conditions. By the end of the course, students grasped the concept that their decisions must be patient specific. They routinely utilized calculations for patient-specific creatinine clearance and their individual assessment of liver function in making their decisions regarding the appropriateness of medication doses.

These students had been introduced to the pharmaceutical care plan concept in a previous course that used the American Society of Health-Systems Pharmacists’ clinical skills program modules. Therefore, pharmaceutical care planning was not an entirely new concept. From the beginning, students seemed to understand the flow of the care plan and what the care plan was asking them to document. However, as we qualitatively evaluated their care plan entries across time, the sophistication of thought expressed in their entries at the end of the quarter was at a higher level than it was in the beginning. Towards the end of the course, students more frequently documented the “finer points” and the rationale behind their recommendations. We interpreted this as evidence of maturation in their thought process. As the quarter progressed, the students seemed to grasp the idea that the more detailed their recommendation the more likely their recommendation would be accepted and implemented appropriately.

Rather than test the students on discrete knowledge gained as a result of exposure to the content that comprised the course, we developed a final examination that would force the students to apply their knowledge gained as a result of the patient assessment and care plan process. Students were given the final patient assessment and care plan document that their group submitted at the end of the quarter as a reference. Questions were designed to assess the student’s ability to define or explain aspects of the patient data they had collected as well as to defend the plan document. However, as we qualitatively evaluated their care plan entries across time, the sophistication of thought expressed in their entries at the end of the quarter was at a higher level than it was in the beginning. Towards the end of the course, students more frequently documented the “finer points” and the rationale behind their recommendations. We interpreted this as evidence of maturation in their thought process. As the quarter progressed, the students seemed to grasp the idea that the more detailed their recommendation the more likely their recommendation would be accepted and implemented appropriately.

As the course progressed, the students demonstrated increased awareness of the need to draw meaning from the data. They were more likely to question data when they collected it and to ask “why” questions to gain a deeper understanding. We believe that the ability to go deeper than the basic surface level accounts for the increase in quality of their care plan documentation.

Evaluation of the Program

Peer evaluation. The course coordinator addressed the Department of Pharmacy Practice faculty members during a regularly scheduled departmental meeting. An overview of the course and a description of the student activities were provided. Faculty members were asked to complete an 11-item survey instrument regarding their impression of the course using a Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

Six faculty members completed the survey instrument. Faculty members responded favorably to all 11 items on the survey instrument (Table 1). Faculty members strongly agreed that the use of the IVR-TTS technology was innovative and new to pharmacy education. They saw this course as a challenge for students and agreed that the course would allow students to further their understanding of topics covered in this and other classes. They saw the teaching approach as a tool to get students talking to one another as well as to professors. Faculty members had a neutral response to the statement regarding the course providing a nice break from the normal class structure. We suspect that faculty members perceived the course as challenging and therefore did not envision the unique design as providing a “break.”

Student evaluation. Students completed the standard course and instructor evaluation at the conclusion of the course. In addition, we asked each student to complete an evaluation regarding the unique design of the course. The survey instrument asked the students to respond to 13 statements using a Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. In addition, students were asked to respond to 2 open-ended questions.

Thirty-three of 34 enrolled students completed the survey instrument. Eighty-eight percent of the students agreed or strongly agreed that the teaching approach used in the Pharmaceutical Care Laboratory course was significantly different from other teaching approaches that they had encountered (Table 2). Therefore, the students viewed this course as unique.

Seventy-five percent of the students indicated that they agreed or strongly agreed with statement 3: “The patient case scenarios helped me understand that patients do not always respond like the textbook says they should.” It was our intent to expose students to case scenarios that illustrated variability in patient response, much like clinicians encounter in real-world patient care settings. We were pleased to see that students gained an appreciation that textbooks teach population norms rather than absolutes.

Seventy-eight percent of the students agreed or strongly agreed that the technology used in the data collection process consumed too much time (statement 7). We suspect that the process of gathering data was perceived by students to be time consuming because all other classes involving patient case scenarios simply provided
Table 1. Faculty Members’ Evaluation of a Pharmaceutical Care Laboratory Course That Used an Interactive Voice Response/Text-to-Speech System

<table>
<thead>
<tr>
<th>Evaluation Statement</th>
<th>Mean (SD)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of IVR-TTS technology is innovative/new to pharmacy education.</td>
<td>5.0 (0)</td>
</tr>
<tr>
<td>The longitudinal approach of cases/follow up is new to pharmacy education.</td>
<td>4.5 (0.6)</td>
</tr>
<tr>
<td>The response to students input (medical/laboratory orders and questions) is new to pharmacy education.</td>
<td>4.2 (1.2)</td>
</tr>
<tr>
<td>This course probably challenged students.</td>
<td>4.8 (0.4)</td>
</tr>
<tr>
<td>This course probably provided a nice break form a “normal” class structure.</td>
<td>4.3 (0.8)</td>
</tr>
<tr>
<td>This course probably allowed the students to further understand topics covered in this and other classes.</td>
<td>4.2 (0.8)</td>
</tr>
<tr>
<td>This course probably forced students to “wake-up” and talk to classmates and other professors about topics covered.</td>
<td>4.7 (0.5)</td>
</tr>
<tr>
<td>This course probably forced students to talk to other professors about topics covered.</td>
<td>4.8 (0.4)</td>
</tr>
<tr>
<td>This course probably provided an opportunity for students to get brief but personal help from the course instructor/professor.</td>
<td>4.0 (1.0)</td>
</tr>
<tr>
<td>This course probably forced students to integrate classmate understandings and explanations with their own.</td>
<td>4.5 (0.8)</td>
</tr>
<tr>
<td>This course probably allowed students to get to know and talk to classmates.</td>
<td>4.5 (0.8)</td>
</tr>
</tbody>
</table>

*Responses based on a Likert scale on which 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree

them with written documents containing all the data they were expected to consider in the assessment and care planning processes. If we are to provide students with classroom exercises that simulate the real world, students must be responsible for finding data on their own.

Less than half (45%) of the students agreed or strongly agreed that the course helped them gain additional confidence in their ability to apply therapeutic information (statement 5). We hoped that more students would have responded positively to this statement. Students completed the data collection, assessment, and care planning process as a group, which may somewhat explain this response. Anytime a learning activity is completed in a group setting, some students gain more than others in the process. Those students who did not engage fully in the discussion and dialogue each week may not have gained confidence or improved their overall comfort level.

Seventy-two percent of the students agreed or strongly agreed that because patient outcomes were affected by their work, they tended to concentrate more and pay more attention to the details and thus believed their learning was enhanced (statement 10). Students seemed to feel responsible for the welfare of the simulated patients; an attitude that we anticipate will carry over into their work in advanced practice experiences during the fourth-professional year. In the standard classroom, instructors find it difficult to assist students with the development of a sense of responsibility for patient outcomes. Students receive feedback in the form of written comments on their work, which students more often than not interpret simply in terms of a grade. Students tend to see their answers as either right or wrong. Students rarely, if ever, receive feedback in the form of patient response against which they must evaluate the appropriateness of their own recommendations or interventions. The longitudinal design and the availability of the technology allowed us the opportunity to provide feedback in terms of patient responses. It is this aspect of the course design that allowed students to develop this sense of responsibility toward the patients.

In the design process for the course we set out to develop a simulated activity that we thought would most closely match the events that occur in real world patient care settings. Yet, when we asked students whether the approach used for data collection and making recommendations made the experience more realistic as compared to other case-based learning activities, they responded in a rather neutral manner. While the data suggest that our attempt to mimic reality was marginally successful, these students may not have a complete understanding of the “reality” of patient care. The majority of the students had little, if any, exposure to patient care prior to the course.

In addition to the statements, we asked the students to respond to the following open-ended questions:

- Did this course, the approach used, or the technology used offer any benefits, advantages, or disadvantages over other courses?
- What modifications would you like to make to this course and/or the technology used in it?

Several students indicated that the course was unique and more like real practice, and they saw this as an advantage. They liked the interactive, dynamic aspect of the patient scenarios. Some students noted that the course allowed them the opportunity to apply what they were learning in other courses with additional attention to details. The idea that their recommendations influenced patient health outcomes was appreciated and positively impacted their sense of responsibility for their work and recommendations. Most students liked the group aspect of the course design; however, one student commented that he/she would have preferred to do the work
individually. Several students suggested that the Web-based genie approach to data collection be retained and the interactive voice response system be dropped. Several students saw the IVR approach as cumbersome, difficult to connect with, and unreliable. Students enjoyed the patient cases that encompassed multiple disease states and recommended that we retain that aspect in future course offerings. The few comments we received regarding things to add to the course dealt with the data collection process or overall course organization of activities.

The primary disadvantages students mentioned were the time-consuming nature of data collection. Despite that in the real world of patient care, students will be expected to sift through several pages of patient chart notes or through electronic data in order to find the information they need, they felt that in the classroom setting the data collection process was an inefficient use of their time.

**DISCUSSION**

Our goal in designing this course was to explore the use of computer telephony as an innovative approach to pharmacy education. Other investigators have utilized Web-based programming as a means to administer longitudinal case studies. The addition of computer telephony to web page programming offered the students the following: (1) the opportunity to verbalize their recommendations, and (2) flexibility in accessing the system via any telephone without dependency on a computer or the Internet. The limitations to computer telephony included: (1) dependency on a telephone, and (2) the number of telephone lines available. This use of computer telephony...
was practical and workable to a satisfactory degree. Coordi-
nation with University technical offices is only required
with regard to assuring the availability of telephone lines.
It is possible to add up to 128 telephone lines to a single
computer. No communication with the University com-
puter network was needed. This innovation may be easily
transferred and duplicated by other schools of pharmacy.
We used a regular desktop computer system equipped with
a dialogic board. The entire system cost less than $2000.
The programming portion was what made it difficult and
time consuming to create. However, an outside company
could be contracted to help develop such a program.

While the initial development of the IVR-TTS system
required extensive time, it was not as challenging as the
implementation process. The implementation process re-
quired more time than we initially expected, but the ex-
perience was rewarding. We were able to see student
progress even before we performed any formal analysis.
The interactive nature and adaptive approach of this in-
novation allowed us to develop a deeper understanding of
individual student strengths and weaknesses.

One difficulty was the limited access to the system
based on the single telephone line provided by the School.
Some students could not reach the system because it was
busy. Students tended to wait and attempt to access the
system the last few minutes before the laboratory. As de-
scribed in the process section, we addressed this issue by
building a text-to-speech web site that was available to
multiple users at the same time. However, students were
still required to leave medical and laboratory orders via
the IVR-TTS system. We anticipate the availability of
more telephone lines before administering this course
again. Student input and evaluation will be taken into
account during the revision process for the course.

SUMMARY
A computer telephony system was developed and
utilized in a Pharmaceutical Care Laboratory course.
Students used the interactive voice response system to
obtain patient data and communicate drug therapy rec-
ommendations. Advantages of this system included the
portability and the realistic approach to patient care. Dis-
advantages include dependency on technology and the lack
of multiple phone lines. Possibilities exist to merge this
technology with Web-based programming to further en-
hance education.

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