Information Technology for Continuous Patient Health Education

Joseph Finkelstein, Jeffrey Wood
Chronic Disease Informatics Program
Johns Hopkins University School of Medicine
Baltimore, MD, USA
jfinkel9@jhmi.edu

ABSTRACT
Information technology for continuous patient health education and counseling could be a powerful means for health promotion and disease prevention. We developed a universal platform for Individualized Continuous Patient Education (iCOPE). This platform is a comprehensive informatics framework for rapid adaptation and dissemination of Comparative Effectiveness Research (CER) products tailored to different categories of health consumers including difficult-to-reach patients. The iCOPE platform implements universal means for customized delivery of CER information in the format of interactive self-paced educational modules, quick “question & answer” guides, and interactive decision aids. In addition, the iCOPE platform will support the innovative concept of continuous patient health education by providing patients with easy access to the interactive CER updates via web, MP3 players and phone-based interactive voice response (IVR) technology. We tested usability and acceptance of educational platforms in patients with chronic health conditions in several clinical settings.

Categories and Subject Descriptors
H.5.2 [User Interfaces]: Input devices and strategies, Prototyping, User-centered design
K.3.1 [Computer Uses in Education]: Computer-assisted instruction (CAI), Computer-managed instruction (CMI), Distance learning

General Terms

Keywords
Multimedia, computer-assisted instruction, health education, human-computer interaction.

1. Introduction
Interactive, computer-based education has the potential to greatly increase interest, because the learner actively participates in the learning process [1]. In addition, the involvement of auditory, visual, and interactive learning strategies can increase recall of information. Computer-assisted educational programs may incorporate features that promote ease of use, be written in multiple languages, be scripted at a level that addresses the needs of low literacy learners, and be viewed as often as needed by a patient [1].

Several studies reported results of using computer technology in educating elderly patients about health conditions. Stromberg et al [2] used a single-session, interactive computer-based educational program about chronic heart failure in elderly patients. They demonstrated that interactive computer-mediated education may be effectively used to increase patients’ knowledge, about heart failure. Another study, conducted by Lin et al [3], evaluated the usability of a touch-screen-enabled personal education program (PEP). The results showed that the system was evaluated as usable and useful, and older adults were satisfied with their experience. Similar findings were reported by Neafsey et al [4] who also evaluated a patient-centered computer-mediated program using touch screen computers. Authors reported high satisfaction of the older adult users, increased knowledge and self-efficacy for avoiding adverse self-medication behaviors.

Elderly patients are less likely than younger patients to seek incidental information on their condition via the internet. [5] Elderly patients therefore are less likely to navigate the internet looking for information about evidence or treatment guidelines for their conditions. More targeted efforts may be needed to reach such populations. Disseminating information via combination of high technology media along with traditional media that are easily usable is helpful [6]. A recent review of barriers and drivers of health IT use by elderly, very ill, and underserved populations revealed that such technology can play a role in offering effective interventions. The consumer perceptions on benefits from use of the system, convenience of use, and familiar technology were all important factors for intervention success [7].

The computer-assisted Comparative Effectiveness Research Summary Guide (CERSG) education is driven by the main concepts of both behavioral and cognitive theories describing different approaches to learning. The main theories employed are architecture of cognition theory [8], cognitive flexibility theory [9] and cognitive load theory [10]. The design principles derived from these theories are as follows: adjusting the amount of information given to a user, providing no more than a specific quantity of information units (7–10) in one educational section;
providing immediate feedback on learner performance; and using personal stories and case scenarios.

Our previous studies clearly established efficacy of computer-assisted health education in disadvantaged populations including elderly, veterans, and patients with various chronic conditions [11-14]. Recent results demonstrated possibilities of developing user interfaces for computer-assisted education which can be successfully implemented in people with limited education, no previous experience in computers, and various limitations in cognition, vision, and locomotion [15, 3]. We also demonstrated that computer-mediated education guided by adult learning theories is more efficient than static educational materials and that it results in more sustainable knowledge gain [11].

In this project we seek to utilize our experience for developing a comprehensive informatics framework for rapid adaptation and dissemination of Comparative Effectiveness Research (CER) products tailored to different categories of health consumers including difficult-to-reach patients. Based on our previous successful experience in computer-assisted education, we will refine the current CO-ED platform to implement and test a novel system for individualized continuous patient education. The iCOPE platform will be specifically designed to support rapid adaptation, customization, and dissemination of the CER products to the difficult-to-reach populations. The iCOPE platform will implement universal means for customized delivery of CER information in the format of interactive self-paced educational modules, quick “question & answer” guides, and interactive decision aids. In addition, the iCOPE platform will support the innovative concept of continuous patient health education by providing patients with easy access to the interactive CER updates via web, MP3 players and phone-based interactive voice response (IVR) technology.

2. System Design

The iCOPE platform supports multi-channel adaptation and dissemination of the CER materials. The e-Kiosk (Fig. 1) represents CERSG in several formats. All formats will utilize information from the underlying iCOPE database where CERSG will be stored in a structured format. The database will contain information on the oral diabetes medication guide (in several languages: English, Korean, Russian, and Chinese) however the database can contain unlimited number of different guides in any language. The iCOPE database is populated by an authoring tool which does not require familiarity with computers or a medical degree. Typically, a trained research assistant populates the database using information from the guide by splitting the information in the guide into a sequence of sections, and further splitting information in the sections into a sequence of consecutive messages (according to previously published guidelines) for each of which a multiple-choice question is

![Figure 1. Model for Continuous Patient/Caregiver Education](image-url)
assigned as well as corresponding multimedia components (audio/video clips).

The final product undergoes iterative quality assurance process ensuring content fidelity and correct translation. Storing the content as a sequence of basic educational messages allows application of various interactive educational algorithms representing the information in a diverse and tailored way based on user preferences and comprehension rate. The e-Kiosk represents information in four ways: self-paced educational curriculum which provides training for the complete content of the CERSG, “question and answer” format which allows for quick access to a specific information, interactive decision aid which allows, based on a serious of questions, to provide patient-specific information, and a personalized brochure which includes sections of the guide chosen by the user as well as a summary provided by the decision aid. All patients in the intervention group will be asked to complete the self-paced CERSG training module.

The e-Kiosks in this project will be represented by a touch screen tablet PC provided to the enrolled patients in hospital, primary care office, and senior center settings. To facilitate patient access to the CERSG information, after completion of the CERSG training using the e-Kiosk, the patients will receive MP3 players in which sections of the curriculum will be recorded as separate files allowing easy browsing of the curriculum. In addition, the same information will be available in an interactive format via a designated web site as well as through interactive voice response system accessible via a regular phone. All patients in the intervention group will receive an access code so that their iCOPE usage will be logged. The MP3 players will be used as an additional incentive to complete CERSG training using e-Kiosk.

An innovative feature of the iCOPE intervention is using multimedia computer-mediated self-paced education to disseminate the CERSG to patients in a tailored way. The tailoring is based on patient preferences of language, education mode, user interface, health communication channel, and personal comprehension rate.

The computer-assisted education (CO-ED) platform, which we developed as a result of our research and development efforts [11-15], allows rapid adaptation and dissemination of a variety of patient education materials including brochures, guides, decision aids, videos, and books [15-17]. The CO-ED platform consists of three major components: (1) a relational database which architecture represents an abstract patient education curriculum, (2) an authoring tool allowing rapid adaptation of patient education materials into a relational database format, (3) and a set of frontend programs designed to disseminate the patient education content via a variety of interactive health communication channels. The CO-ED platform currently supports internet-enabled, wireless, and stand-alone computing devices including touch screen kiosks, tablet PC, cell phones, laptops, PDA, iPod, IVR, and Wii. The CO-ED
platform is implemented on the laptop and tablet PC in Visual Basic 6.0 and Microsoft Access. The Wii implementation uses Flash 7.0 while the PDA uses Flash Lite 2.1. The iPod implementation is written in Objective C while cell phone implementations were developed using Java 2 Mobile Edition.

The user interface is tailored towards individuals with no computer experience. The CO-ED platform may be embedded in home telecare applications to support comprehensive chronic disease management programs [18-20].

3. Results

The iCOPE system has been successfully designed and is ready to be adapted for CERSG information. A large scale study has been designed to measure the effectiveness of the iCOPE system as an intervention method. An evaluation of acceptance study was conducted in three different clinical settings using different CO-ED platforms.

The CO-ED platform has been successfully designed, implemented, and tested with different educational curriculums on many different devices including touch screen kiosks, tablet PC, cell phones (Fig. 3), laptops, PDA, iPod, IVR, and Wii. The CO-ED algorithm is shown in Fig. 2.

Once all questions in the educational section are answered correctly, the quiz portion begins. The quiz questions (Fig. 6) are a subset of the educational questions. The patient is asked a question without receiving a tip beforehand and moves on to the next question whether they answered correctly or incorrectly. If any questions are answered incorrectly, the patient repeats the learning section. If all are answered correctly, the patient moves on to the next section until the curriculum is completed.

The CO-ED system consists of an educational section and a quiz section. In the educational section the patient receives an educational tip (Fig. 4) with accompanying media such as recorded audio and images. Then the patient is asked a multiple choice question about the tip they just received. If the question is answered correctly, the patient is shown a screen telling them they answered correctly (Fig. 5) with images and audio to provide positive reinforcement. Then the patient moves on to the next tip. If the question is answered incorrectly, the patient is told they answered incorrectly and the educational message is repeated before the question is repeated until the correct answer is provided.
The e-Kiosk can successfully generate personalized brochures (Fig. 7) based upon a patient’s knowledge needs. We conducted an evaluation of acceptance in several clinical settings. Patients were asked to use the CO-ED system while they were waiting in an Anticoagulation Clinic, Emergency Room, and Multiple Sclerosis Center. Attitudinal surveys and semi-structured, in-depth interviews were used for the evaluation of CO-ED acceptance. The interviews were conducted by two research assistants trained to perform qualitative analysis. During an interview one research assistant interacted with a patient and another research assistant documented patient responses. Before using the CO-ED the patient were asked to sign an Informed Consent Form approved by IRB.

Out of 46 patients invited to use CO-ED at the Anticoagulation Clinic 44 patients agreed to use it and to give their feedback. Patient age was in the range of 20 to 82 years. 57% did not have any computer experience. 91% stated that they prefer using CO-ED as an education tool rather than a brochure. 86% claimed that they would use such a tool at home and would advise other patients to use CO-ED for disease-specific education. 80% stated that they learned new information about their disease using CO-ED. 2% felt that repetitive messages are annoying. 98% felt that immediate feedback was very helpful.

Patients presented to the Emergency Room for treatment of asthma exacerbation were asked to use the Pocket PC platform. Of 55 eligible patients, 5 refused to participate. Patient age ranged from 21-68 years and 70% had no computer experience. Their Asthma knowledge score changed from $12\pm17$ to $19\pm14$ ($p<0.01$). 93% of patients preferred using CO-ED rather than a brochure. 89% of patients claimed that they would advise other patients to use CO-ED. 78% of patients stated that they learned new information by using CO-ED.

All patients (N=13) surveyed at the Multiple Sclerosis center stated that they would advise other MS patients to use such a program. The majority of the patients (85%) were interested in using such a program in the future. 92% of patients surveyed found the program “not complicated at all.”

4. Discussion

The iCOPE platform has been designed and is ready for CERSG information to be integrated. The platform should allow patients to be better informed and able to make the best decisions about their individual health care. Having many different platforms for computer education allows the system to reach as many people as possible and allows patients to be kept up to date on any changes or updates for the duration of their health care needs.

The iCOPE intervention platform will be fully implemented as a working system over fifteen months and will include three consecutive stages: (1) preparing design specifications, writing the algorithms and reports by the key personnel, (2) laboratory pre-testing of the iCOPE intervention, and (3) pilot-testing of the iCOPE intervention in elderly. Computer-assisted education can be implemented as a stand-alone platform [20-21] or can be a component of a comprehensive home-based telemanagement program aimed at facilitating guideline-concordant care of chronic health conditions [22-27].

5. Conclusion

The iCOPE platform is a viable system to test in continuous patient education. Initial evaluation of acceptance using the prototype CO-ED system indicates widespread patient acceptance of computer learning systems.
in multiple clinical settings with several different platforms. The iCOPE system can be efficiently designed and implemented for many conditions, and is recommended for future use, expansion, and research.

6. Acknowledgements

This research was supported in part by a grant R18HS19313 from the Agency for Healthcare Research and Quality (AHRQ). The authors are grateful for the suggestions of the reviewers of this paper.

7. References


250