An Interactive Technology Approach to Educate Older Adults About Drug Interactions Arising from Over-the-Counter Self-Medication Practices

Abstract
An interactive computer program (Personal Education Program [PEP]) designed for the learning styles and psychomotor skills of older adults was used to teach older adults about potential drug interactions that can result from self-medication with over-the-counter (OTC) agents and alcohol. Subjects used the PEP on notebook computers equipped with infrared sensitive touchscreens. Subjects were recruited from senior centers. Those who met age, vision, literacy, independence, and medication use criteria were randomly assigned to one of three groups: (1) PEP plus information booklet; (2) information booklet only; or (3) control. A repeated measures (three time periods 2 weeks apart), three-group design was used. Users of PEP had significantly greater knowledge and self-efficacy scores than both the conventional and control groups at all three time points. The PEP group reported fewer adverse self-medication behaviors over time. Reported self-medication behaviors did not change over time for either the conventional or control groups. Subjects indicated a high degree of satisfaction with the PEP and reported their intent to make specific changes in self-medication behaviors.

Key words: aging, drug interactions, self-medication, interactive software, hypertension.

Many over-the-counter (OTC) medicines, nutritional supplements, and alcohol conflict with prescription medicines (Centaruk & Aaron, 1994; Task Force for Compliance, 1994; USGA, 1995; Honig & Gillespie, 1995; Manasse, 1995; Salzman, 1995). Resulting drug interactions pose major impediments to optimal health in older adults. Data from our previous research suggest that older adults frequenting blood pressure clinics have self-medication practices that put them at risk of adverse drug interactions (Neafsey & Shellman, 2001). Further, their knowledge concerning potential interactions arising from self-medication practices and self-efficacy to avoid such interactions was low (Neafsey & Shellman, 2002). An ideal opportunity for community health nurses to educate older adults about potential OTC and prescription drug interactions occurs during blood pressure monitoring (e.g., at clinics, wellness centers, home visits) (Neafsey, Strickler, Shellman, & Padula, 2001; Shellman, 2000). This article describes how an interactive multimedia software program called “Preventing Medicine Conflicts” was used in an extended clinical trial to increase older adults’ knowledge of potential drug interactions arising from self-medication, increase their self-efficacy (confidence) in how to avoid such
interactions, and decrease reported adverse self-medication behaviors.

**HYPOTHESES**

Specific hypotheses related to the outcomes of the PEP tested in the extended clinical trial were as follows:

1. Subjects using the Personal Education Program (PEP) will show greater knowledge of potential interactions of prescription medications with OTC medications and alcohol than will nonusers.
2. Users of the PEP will show greater self-efficacy for avoiding drug and alcohol interactions than will nonusers.
3. Users of the PEP will report fewer adverse self-medication practices over time than will nonusers.

**PEP SOFTWARE DESIGN**

Details of the design and formative evaluation of the PEP are given elsewhere (Neafsey et al., 2001; Strickler & Neafsey, 2002). Briefly, the PEP was designed as an intuitive, interactive computer program featuring an infrared touchscreen with on-screen buttons for users. The interface design was based on the learning styles of older adults (Ansley & Erber, 1988; Nielson & Shaefer, 1993; Morris, 1994). Infrared sensitive touchscreens were designed and built to the authors’ specification (Carroll-Touch, Round Rock, TX) and were attached to the LDC panels on IBM ThinkPad 380Z notebooks by Velcro straps.

Focus groups of older adults evaluated PEP components in a formative manner during development (Strickler & Neafsey, 2002). The humanoid characters used in the PEP animations are gender-, race-, and age-neutral. The text of instruction and animation screens are written at a Fleish-Kincaid grade 5 reading level in a large, bold font (18 and 24 point) to accommodate expected functional health literacy levels and eyesight (Jackson, Davis, Murphy, Bairnsfather, & George, 1994; Laubach & Koschnick, 1977; Plimpton & Root, 1994).

The navigation buttons are “Menu,” “Back,” “Next,” and “End.” When an animation appears on the screen, contrasting “Replay,” “Pause,” and “Play” buttons emerge for the user to control the animation play. The button size allows for easy target access for individuals with such conditions as arthritis or hand tremors.

Interactive questions are interspersed throughout the program. The questions are parallel items to those on the knowledge test. They are short scenarios presenting potential self-medication dilemmas. The choices are selected by touching buttons labeled A, B, C, or D. Each “incorrect” choice triggers a feedback message in red that explains why the choice is undesirable, and then the user is directed to “try another letter.” When the correct answer is selected, feedback in dark blue states why the choice is the most desirable one and directs the user to “touche the ‘NEXT’ button to continue.” A user can skip the questions altogether by touching one of the navigation buttons to move to another section of the program.

The program content dealing with antacids, calcium supplements, and acid reducers, was pilot tested with 60 older adults recruited from local seniør centers (Neafsey et al., 2001). The sample was randomly divided into experimental (pilot use of the PEP) and wait-list control groups of 30 subjects each. The PEP group was tested for outcome variables (knowledge and self-efficacy) immediately after PEP use; the comparison group (control) was tested before their PEP use. Users of the PEP had significantly greater knowledge and self-efficacy scores than controls. The PEP was revised following the pilot evaluation study. The finalized PEP contains a total of 80 min of animation and interactive questions. The content is divided into four main sections: Blood Pressure Medicines, Blood Thinners, Antacids and Acid Reducers, and Pain Relievers.

**EXTENDED CLINICAL TRIAL**

Senior Honors nursing students recruited subjects from local senior centers. Those who met age, vision, literacy, independence, and medication-use criteria were randomly assigned to one of three groups with a goal of retaining 22 subjects per group to yield sufficient statistical power (0.80) to detect medium-to-large differences between groups (Moderate Effect Size = 0.36) at an alpha of 0.05 for a Linquist Type 3 repeated measures analysis of variance (RM-ANOVA) with one between factor (group) and one within factor (time) (Hintze, 1996). Thirty-three subjects per group were recruited to allow for a 33% attrition rate for the study, which required subjects to make three visits every other week to the senior center clinic.

**INCLUSION/EXCLUSION CRITERIA**

Subjects were at least 60 years of age by self-report. Criteria developed and validated by the MacArthur Research Program in Successful Aging (Wallsten, Sullivan, Hanlon, Blazer, Tyrey, & Westlund, 1995) were used to select study participants with independent physical and cognitive functioning. Study participants were able to: (1) perform activities of daily living on the Katz (1970) tool and seven of eight combined Nagi and Breslau functional items (Nagi, 1976; Rosow & Breslau, 1966); (2) answer 6 of 10 items on the Short Portable Mental Status Questionnaire (Pfeiffer, 1974); (3) have a reading comprehen-
sion score of at least grade six on the Rapid Estimate of Adult Literacy (Davis, Long, Jackson, Mayeaux, George, Murphy, & Crouch, 1993); and (4) be living independently. Subjects were screened for visual acuity using a pocket vision screener (Rosenbaum, Graham-Field Surgical Co., New Hyde Park, NY). To be included in the study, subjects had to have a visual acuity of at least 20/100, with corrective lenses as needed.

Study participants also met the following criteria: taking either prescription antihypertensives or anticoagulants in conjunction with OTC calcium supplements, antacids, H2 blockers (acid reducers), or pain relievers. These additional criteria were invoked because they reflect the audience who would most be interested in, engaged by, and motivated to use the content of the PEP.

Collected data conformed to the federal Hum-1 45-CFR46 Use of Human Subjects. Data were either anonymous (self-report instruments and surveys) or confidential (assessment of inclusion criteria) and posed no physical or psychological risk to subjects. Individual subjects were not identified in any analyses or reporting of data and results. All study participants were asked to sign an informed consent form that was read to them and explained if needed.

INSTRUMENTS

Four instruments to measure outcomes were developed and validated: a measure of self-efficacy, an objective test to measure knowledge, a self-report measure of medication use, and a satisfaction instrument. Information gathered during the focus groups guided the choice of phrasing (i.e., specific drugs mentioned, language used with reference to behaviors). Instruments were written at the fifth grade reading level and printed in a large (14-point) arial font. Instruments were reviewed for content validity by a panel of three expert judges (a nurse researcher, a pharmacologist, and an instrument development specialist) using standard procedures for item review (Grant & Davis, 1997). The methods used for validating the instruments are described elsewhere (Neafsey et al., 2001).

Self-Efficacy Measure

The 13-item self-efficacy instrument was pilot tested with 134 volunteers recruited from area senior centers not involved in the clinical trial. Data from the pilot testing were subjected to an exploratory principal factor analysis (PFA) to study the factor structure underlying responses (Fereketich & Muller, 1990; Tabachnick & Fidell, 1996). The structure of the self-efficacy measure was found to be unidimensional; therefore a single internal consistency estimate for the scale was determined (Cronbach’s alpha estimate = 0.95). Item loadings on the single factor solution were all > 0.63.

The self-efficacy instrument was administered to 27 older adults meeting study criteria at a local senior center not involved in the clinical study and was re-administered 1 month later without intervention. The mean score on the first administration was 1.96 ± 1.01 and the mean score on the second administration was 2.16 ± 1.22. The 1-month test-retest reliability estimate was 0.81 ($p < 0.001$).

Objective Measure of Knowledge

An initial pool of 27 multiple choice questions was written based on the PEP content outline. Each question was built on examples of actual self-medication behaviors and tests both knowledge and application levels of Bloom’s taxonomy of the cognitive domain (Bloom, 1956). Each item has one correct response and three distracters based on common misconceptions about OTC agents and alcohol. Content validity was assessed and a pool of 25 items was pilot tested with the same individuals who piloted the self-efficacy instrument. Difficulty and discrimination indices were used to select the most content-valid set of 20 items, which were then revised to improve clarity and retested to produce the final item pool of 17 questions. Difficulty indices fell between 0.25 and 0.75 and discrimination indices were all > 0.20 (Owen, 1993). Cronbach’s Coefficient Alpha for internal consistency, was 0.68, a result consistent with an instrument with heterogeneous content administered to a naïve group. A 1-month test-retest reliability estimate was 0.50. One expects a lower test-retest coefficient on multiple choice knowledge tests with naïve subjects, because they use random guessing to answer items.

Medication Use Instrument

The medication use instrument consisted of a series of response options to check off, thus reducing response burden. Concurrent validity was estimated from a mail survey of 25 married couples who completed the survey twice, once to self-report one’s own medication-use behavior and once to report the mate’s pattern of behavior. Individual items were entered for analysis and scored to indicate whether the pairs’ responses matched for each item. An 80% overall match rate across all the items within each survey section was be taken as supporting evidence of concurrent validity of self-report. This degree of concurrent validity is acceptable for newly developed measures (Nunnally & Bernstein, 1994). All sections of the instrument had a match rate of 85% or greater. The overall match rate was 88% for wives reporting husbands’ use and 87% for husbands.
reporting wives’ use. Paired t-tests were used to compare the match rate of husbands vs. wives. There was no significant difference between the match rate of husbands vs. wives for any section of the instrument or for the overall instrument. The data were also assessed for concurrent agreement using the Kappa test, a measure of reliability of two categorical variables (Fleiss, 1981). The high Kappa values (> 0.75) among specific categories (e.g., anticoagulants, antihypertensives, calcium supplements, acid reducers, and pain relievers) provide support for the concurrent validity of self-report on the medication use survey.

**Estimate of Adverse Self-Medication Behavior Score**

Data from the pilot test of the medication use instrument (Neafsey et al., 2001) were used to develop an adverse self-medication behavior score. An expert panel rated a list of self-medication behaviors using a five-point scale from 1, “very unlikely” to 5, “very likely” to cause an interaction. The expert panel consisted of a doctorally prepared registered pharmacist with research expertise on OTC medications, a pharmacologist, and a community registered pharmacist. The importance weight for each adverse self-medication behavior was the mean of the expert panel ratings. The total score is the weighted sum of the scores for the items checked on the instrument. The final scale was tested with the pilot study data.

Normality of the total behavior score was tested with Shapiro & Wilk’s W statistic. This is a robust measure that is less influenced by extreme values that may unduly influence the sample mean. The ratio of the skewness value to its standard error was 3.5 for the total behavior score, indicating that the distribution was skewed to the right. The ratio of the kurtosis value to its standard error was 2.2, indicating slightly longer tails than a normal distribution. The W statistic was 0.85 and normality was rejected at the 0.05 level of significance.

The log transformation is a standard way to make right-skewed distributions symmetric. Consequently, the log of the total behavior score was examined. The ratio of the skewness value to its standard error was –0.43, indicating symmetry of the distribution. The ratio of the kurtosis value to its standard error was –1.49, indicating normally distributed tails for the log total behavior score. The W statistic was 0.9643; therefore, normality was not rejected for the log transformation. Thus, the log of the total adverse self-medication behavior score was used in parametric statistical analyses.

**Satisfaction Instrument**

The same 14-item satisfaction instrument developed for the pilot study was used in the extended clinical trial (Neafsey et al., 2001). Eight items addressed the ease of program use, program content, and suitability of program content, and six items addressed the perceived likelihood of making behavior change following program use. A five-point self-response format ranging from 1, “strongly disagree” to 5, “strongly agree” was used. In addition, the participants were asked to respond to the following: “Things I liked about the program,” “things I disliked about the program,” and “changes I plan to make soon after using this program.”

**ANALYSES**

The BMDP statistical package (Dixon, 1990) was used for data analysis. Both univariate and multivariate outlier screening techniques were used. Data were inspected for multivariate outliers based on Mahalanobis distance values. Missing data at the item level were imputed with regressed scores from available variables. In any instance of ≥30% missing data, casewise deletion occurred.

**RM-ANOVA** with one between factor (group) and one within factor (time) was performed on self-efficacy, knowledge, and log adverse self-medication behavior scores. The Student-Newman-Keuls test was used post-hoc to determine significance among means at each time point. The Levine’s Test for variance was not significant for any of the group means indicating homogeneity of variances. Therefore, pooled variance was used in the post-hoc tests.

**RESULTS**

Random assignment to groups was achieved because there were no initial differences among the groups in age, education, gender, medication use (antihypertensives, low-dose aspirin, warfarin, antacids, calcium supplements, acid reducers, pain relievers), or adverse self-medication behavior score. A total of 85 subjects completed the study: 30 PEP subjects, 30 conventional subjects, and 25 controls. Three PEP, three conventional, and four control subjects were unable to complete the three study visits due to illness of the subject or spouse. Three control subjects declined the opportunity to use the PEP software at the end of the third visit. These subjects were omitted from the sample.

The mean age was 73.8 (SD = 6.5) and the mean years of education was 12.6 (SD = 3.2). The sample was largely female (73%) and Caucasian, not of Hispanic origin (98%).

There was a significant group effect for both self-efficacy ($F [2, 82] = 53.48, p < 0.0001$) and knowledge ($F [2, 82] = 34.76, p < 0.0001$). There was no significant time effect or interaction of group with time for either self-efficacy or knowledge scores. Post-hoc analyses
indicated that both PEP and conventional groups had significantly higher self-efficacy and knowledge scores than controls at all time points \((p < 0.05)\). Furthermore, the PEP group had higher self-efficacy and knowledge scores than the conventional group at all three time points \((p < 0.05)\). (Figs 1 and 2). The effect sizes of the PEP vs. the conventional intervention were large for both self-efficacy \((ES = 1.30)\) and knowledge \((ES = 1.08)\) scores at time 3.

Self-efficacy and knowledge scores were not significantly correlated with one another at any time point. This indicates that the self-efficacy and knowledge instruments measured separate constructs as intended (Murdock & Neafsey, 1995; Neafsey, 1997, 1998). Neither self-efficacy nor knowledge scores were significantly correlated with age or education for any group at any time.

There was a significant interaction of time with group for the adverse self-medication behavior scores \((F [4, 164] = 2.46 p < 0.05)\). There was a significant decrease in the adverse self-medication behavior score for the PEP group over time. \((F [2, 58] = 3.92 p < 0.05)\). There was no significant change in adverse self-medication behaviors of the conventional and control groups over time (Fig. 3).

Post-hoc analyses revealed that adverse self-medication behavior scores decreased significantly for the PEP group from time 1 to time 3 \((p < 0.05)\) with an effect size of 0.54.

There were no significant differences in overall mean PEP satisfaction scores among the groups. Table 1 gives

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**Figure 1.** Self-efficacy scores for PEP (software plus booklet, \(N = 30\), conventional (booklet only, \(N = 30\), and control (no intervention, \(N = 25\)) groups at visit 1 (immediately following intervention), and visits 2 and 3 (2 and 4 weeks later). Score is the overall mean score on the 13-item SE instrument where response options ranged from 1 = “Not sure” to 5 = “Totally sure.”

**Figure 2.** Knowledge scores for PEP (software plus booklet, \(N = 30\), conventional (booklet only, \(N = 30\) and control (no intervention, \(N = 25\). groups at visit 1 (immediately following intervention), and visits 2 and 3 (2 and 4 weeks later). Score is the percent correct on the 17-item instrument.

**Figure 3.** Adverse self-medication behavior risk scores for PEP (software plus booklet, \(N = 30\), conventional (booklet only, \(N = 30\) and control (no intervention, \(N = 25\) groups at visit 1 (immediately before intervention), and 2 and 3 (2 and 3 weeks later). Score is the sum of the risk scores for the adverse self-medication behaviors reported on the medication use survey.
the mean satisfaction scores for all groups considered together. The average participant rating of mean satisfaction with the PEP was 4.52 (SD = 0.60) on the five-point scale.

Subjects responded to open-ended questions asking them to list things they liked and disliked about the PEP (Fig. 4). Aspects of the PEP listed by subjects as “likes” were: useful new information (54%), made complicated information understandable (28%), animation sequences (11%), and ease of program use (7%). Other aspects of the PEP that the subjects (three or more) liked were the pace (slow enough to read and think), the interactive questions, and the concise text.

Sixty-one percent of the subjects stated they had no dislikes about the PEP, and 9% left the section blank. Aspects of the PEP mentioned as dislikes (by three or more subjects) were that the animations moved too slowly (6%) and that it was too repetitive (4%).

Subjects were asked to indicate their degree of agreement with statements concerning behavior changes after using the PEP. There was no significant difference in the overall mean change score among groups. The overall mean change score was 4.12 (SD = 0.91) on the five-point scale. Table 2 gives the mean change scores for both groups considered together.

Subjects responded to an open-ended question asking them to list changes they will make in how they use medicines soon after using the program (see Fig. 4). Thirty-eight percent of the subjects listed changing the timing of taking medications. Thirty percent mentioned specific OTC medications they would take differently, e.g., taking calcium supplements or antacids 2 hrs apart from other medications such as digoxin, thyroxine, etc., or taking aspirin or acid reducers at least 2 hrs apart from drinking alcohol. Seventeen percent stated they would be more aware and careful about conflicts of OTC agents with prescription medicines in the future. Other behavioral changes listed by 5% or more of the subjects were changing the specific OTCs they would take (e.g., taking acetaminophen instead of aspirin-like medications with alcohol or other medications).

Table 1. Degree of Satisfaction with PEP

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean (SD)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The movies were useful.</td>
<td>4.48 (.86)</td>
</tr>
<tr>
<td>The (interactive) questions were useful.</td>
<td>4.42 (.94)</td>
</tr>
<tr>
<td>The program was easy to use.</td>
<td>4.60 (.71)</td>
</tr>
<tr>
<td>The program was fun to use.</td>
<td>4.53 (.74)</td>
</tr>
<tr>
<td>The program was easier to understand than</td>
<td>4.52 (.72)</td>
</tr>
<tr>
<td>medicine labels.</td>
<td></td>
</tr>
<tr>
<td>Much of the information in the program was</td>
<td>4.18 (1.05)</td>
</tr>
<tr>
<td>new for me.</td>
<td></td>
</tr>
<tr>
<td>I will recommend this program to my friends.</td>
<td>4.74 (.56)</td>
</tr>
<tr>
<td>I would choose to use another program</td>
<td>4.46 (.60)</td>
</tr>
<tr>
<td>like this one in the future.</td>
<td></td>
</tr>
<tr>
<td>Overall mean satisfaction score</td>
<td>4.52 (.60)</td>
</tr>
</tbody>
</table>

*Mean degree of agreement with statement: 1 = strongly disagree to 5 = strongly agree. All subjects considered together. Complete data were available for 83 of 85 subjects.

Question: Please tell us what you liked about the program.

Examples of qualitative responses:

- Actually showed what is really going on. The picture stays in your mind.
- Easy to understand, well explained.
- I liked the fact that I could understand the program at my own speed.
- Very thorough information, it will stay with me.
- I found it very helpful in that it gave me information that had not been brought to my attention before.
- Highlighted correct ideas in an encouraging way.
- Many of my questions were answered clearly.
- This helped me learn how to take better care of myself. Thank you.
- Information such as this is vital due to my being on a blood thinner.

Question: What changes (if any) will you make in how you use medicines soon after using this program?

Examples of qualitative responses:

- I want to schedule a complete reexamination of the drugs currently prescribed by the doctor, e.g., blood pressure medication.
- Plan to make a chart for taking medicines and vitamins.
- Taking calcium pills and antacids 2 hrs after other medication.
- Read labels more carefully.
- Take medicines on time and know what medicines are for.
- Think before I act. Question pharmacist when I have a new prescription.
- Be careful about taking aspirin and aspirin-like medications with alcohol or other medications.
- Take acetaminophen instead of aspirin as I take blood pressure medication. Be careful about mixing medications.

Figure 4. Examples of responses to open-ended questions.
CONCLUSIONS

Data from the extended clinical trial of the PEP support all three study hypotheses. Users of the PEP showed greater self-efficacy for how to avoid drug and alcohol interactions than did conventional and control subjects. Subjects using the PEP showed greater knowledge of potential interactions of prescription medications with OTC medications and alcohol than did the conventional and control subjects. Users of the PEP had lower adverse self-medication behavior scores over the time frame of the study, while the adverse self-medication behavior of the conventional and control subjects was unchanged. Subjects indicated a high degree of satisfaction with the PEP and indicated that they were likely to make changes in their self-medication behaviors following use of the PEP.

That knowledge, self-efficacy and adverse self-medication behavior scores were not correlated with age or education for any group at any time suggests that the PEP was effective regardless of the age and education of the subjects in the sample. Future studies using subjects with lower education levels are needed to confirm whether the PEP approach can help remove barriers of advanced age and limited education in health literacy efforts.

The sample used for this study was recruited from senior centers in communities surrounding a research university located in a rural New England area. Consequently, the subjects were primarily white females. There was insufficient power to compare the effectiveness of the PEP among races and between genders. The results of this study therefore cannot be generalized to the entire population of older adults. Currently the PEP is being implemented on a larger scale in two racially and economically diverse urban communities. Data from future studies will help determine if the PEP is equally effective with both males and females and with whites, African Americans, and English-speaking Latinos. Moreover, future research will include study of a sample population in a home setting to support the efficacy of the approach across settings as well.

These results demonstrate that the study sample of older adults benefited significantly from this model of health education practice. Moreover, augmentation of conventional health education practices via an interactive computer program provided participants with a significant overall advantage of increased knowledge and self-advocacy skills. Prospective studies may ultimately reveal that health education presented in this manner benefits older adults in the assimilation of knowledge, skills, and behaviors necessary to avoid costly medication interactions and their consequent adverse health effects.

The implications for future practice are that the delivery of health information to older adults via touchscreen-equipped computers has the potential to revolutionize public health education by community nurses.* Topics for future PEPs could include information essential to self-care for specific conditions such as diabetes, arthritis, etc. Additionally, this type of interactive program design may provide the community health nurse with a greater opportunity to assess knowledge deficits and skills and subsequently provide both timely and appropriate interventions and evaluations. Personalized health education programs for older adults based on this model could promote meaningful continuity of care and amend any potential gaps from clinical to home care settings.

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*Contact the first author to obtain the Personal Education Program, Preventing Medicine Conflicts.
REFERENCES


