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Formative Research for Interface Design for Older Adults: Reducing Adverse Self-medication Behaviors

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Introduction

In 2002 our research team released *Preventing Conflicts Between Medicines*, an interactive learning software program designed for the aesthetic preferences and psychomotor skills of older adults (those aged 60 and older). (Neafsey, Strickler, Shellman & Padula, 2001; Neafsey, Strickler, Shellman & Chartier, 2002). The study was one of the first to document older adult's aesthetic preferences for visual presentation of health-related information via interactive media, as well as their needs with respect to speed of information delivery, typographic presentation, and visual contrasts of imagery on the screen. (Strickler and Neafsey, 2001; Strickler and Neafsey, 2002). In a controlled, clinical trial, older adults who used the program on touch-screen-equipped laptop computers demonstrated increased knowledge of potential drug interactions, enhanced perceived self-efficacy for avoiding the interactions, and reported fewer harmful practices involving use of over-the-counter medications (self-medication) as compared to control groups receiving either a conventional print-based intervention, or standard care.

In the current study, a *Next Generation Personal Education Program*, or (*PEP-NG)*, is being developed to update and integrate use of the now-validated learning program into natural health care environments as a means to improve patient/provider communication and health care practice regarding potential drug interactions. The earlier project was a stand-alone, educational intervention introduced to patients in their homes or in blood pressure clinics by visiting nurses (Neafsey, et al., 2002). In the current study we are exploring use of the program as a tool to enhance provider effectiveness in working with patients to determine optimal plans for medicine-taking that fit with patient's daily habits and practices, as well as to enhance the patient's knowledge and skills to reduce high-risk self-medication behaviors (Neafsey & Shellman, 2001).

As before, our research team regards design of the program interface – its visual appeal, readability, and usability by older adults – to be key to the success of the program as a tool for health behavior change in this population. In this paper we will discuss the formative, user-centered research processes that were used to develop the successive prototypes that led to design of the final program.

Scope of the problem

Failure of older adults to take medications properly is estimated to be a factor in more than a quarter of emergency room visits and 10% of nursing home admissions with a total cost of over $25 billion annually in the U.S. (Gurwitz et al., 2003; Salzman, 1995; Tafreshi, Melby, Kaback & Nord, 1999; Task Force for Compliance, 1994). *It has been estimated that 10% of adverse drug events may be attributed to communication failure between the provider and patient (IOM, 2000).* Failure to take medications as prescribed and adverse self-medication practices can result in drug interactions that can be fatal. In a health environment that promotes polypharmacy for older adults—a group that is less well able to see, hear, and understand medical information than the general population—a need exists to educate both older adults and their providers about the dangers of adverse drug interactions arising from self-medication.

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Potential Benefits, and Expected Impact on Patient Outcomes.

The current project identifies and deals with the adverse self-medication practices of older adults – specifically interactions among prescription antihypertensives (for high blood pressure) and over-the-counter (OTC) medications and alcohol. It takes specific steps to correct misconceptions and dangerous practices common among older adults. Older adults have large knowledge deficits with respect to interactions of prescription and over-the-counter medicines, and have low confidence levels in how to avoid serious interactions, but have a keen interest in learning how to avoid them (Neafsey & Shellman, 2002). For example, we found that many older adults with high blood pressure self-medicate for pain with aspirin-like agents containing ibuprofen or naproxen (Neafsey & Shellman, 2001). Frequent use of these drugs can raise blood pressure and reduce the effectiveness of prescription blood pressure medications. By switching to acetaminophen for pain-relief, patients can return to target blood pressure readings.

Our project addresses six problems identified by the Institute of Medicine (IOM) as linked to adverse medication events: 1) inaccurate medical histories, 2) inadequate patient knowledge of their health conditions and medications, 3) poor treatment adherence, 4) medication errors (including self-medication errors), 5) low utilization of preventative health care-services, and 6) poor patient satisfaction with the patient-provider relationship (IOM, 2000). Our project offers an intervention to educate and effect behavior change at both the provider and patient level. It is an example of "disruptive innovation" (Christensen, Bohmer, & Kenagy, 2000) whereby a technological advance (mobile, wireless, touch-sensitive computer) enables a leap to a novel and optimal method to provide health education for older adults and improve their health outcomes.

Our research will provide answers as to how the innovation can improve the collection of patient self-medication information, increase patient knowledge of their chronic health condition (hypertension) and prescribed medical regimen, and improve health communication to foster behavioral change resulting in better medication adherence and safer practices. The program's customized and tailored education and communication targets both patients and providers separately by following guidelines concerning health literacy proposed by the IOM (2001). Further, our research findings will provide direction for other investigators and software designers in their development of projects for older adults and provide a model for user-testing (Strickler & Neafsey, 2002a). The project may serve as a model implementation that allows a rapid

paradigm shift in how older adults access health information and communicate with clinicians. It also stands to advance health communication research and practice by defining optimal use of information technology for the older adult population within the health care system, and by employing controlled measures of health behavioral outcomes for patients using user-centered, user-tested information media.

A basic premise guiding design of the original program was that older adults with reading skills and a knowledge of biology/physiology average for their age would likely feel bewildered by complex drug interaction information presented as text alone. Given the rise in the number of medications available over-the-counter (often advertised as "safe" by themselves), and the range of potentially harmful interactions involving blood pressure medications (antihypertensives) and substances as ordinary as antacids, cold/allergy medications and alcohol, the basic information is difficult even for nurses to comprehend, much less older patients (Neafsey & Shellman, 2002a; 2002b). The PEP-NG addresses this through use of attractive, simplified anatomical animations of the effects of several classes of these pharmaceuticals on the body, and the ways in which they interact when taken together. Outcomes from our previous studies strongly suggest that by enabling experimental subjects to "see" these effects via inviting animations, the information on drugs and their potential interactions are understood, remembered, and retained to a greater extent than among control participants. We anticipate that improved comprehension of the pharmacological processes involved in common drug interactions will prepare both patients and health care providers in this study to experience better communication during clinical visits, and will enhance self-efficacy in both groups to take preventive action.

Specific aims for the project are: 1) to design a visual interface for the *PEP-NG* with desirable characteristics and ease of use for both older adults and primary care providers 2) to increase clinician self-efficacy for teaching and advising older adults about potential drug interactions; 3) to increase patient knowledge and self-efficacy for avoiding harmful interactions arising from self-mediation practices; 4) to reduce self-reported adverse self-medication behaviours associated with common drug interactions; 4) to improve patient adherence to their prescribed drug regimen; 5) to achieve target blood pressure readings and f) to demonstrate improvement in the provider-patient relationship among patients using the *PEP-NG*. Health outcomes and health care utilization will be compared between a *PEP-NG* use group (the experimental group), and a control group over 12 weeks. After 52 weeks a cost-benefit analysis will be conducted.

Patients will access the program on wireless, stylus-activated, touch-screen tablet PCs linked to an intranet portal in the provider's waiting room. Data will be analyzed via secure server, and educational animations that are relevant to the patient's risk behaviors (as identified in the patient's self-report of medication practices) will be delivered on the tablet PC. Summaries of reported behaviors and corrective strategies will be printed for both patient and provider to enhance communication during visits.

Design Development

In the earlier study, conventional paper and pencil questionnaires were used to assess patient's knowledge, medication-taking behaviors, and medication self-efficacy (their confidence in their ability to avoid harmful

drug interactions), as pre-test, post-test, and post-post-test measures. In the current study, these pre-validated instruments are embedded in the computer interface as sets of interactive questions for the patient to answer. The program therefore captures patient's knowledge, beliefs, and behaviors regarding medication use. It then uses this information to deliver learning content specific to the patient's particular risks and self-medication practices.

A long-term goal for the project is to make the program easily and widely distributable to older adults. Whereas the earlier educational program was delivered via CD-Rom and was therefore confined to a fixed-location delivery modality, (large animation files created in Adobe AfterEffects were delivered in Quicktime format via a Macromedia Authorware interface), the next generation user interface is being programmed and animated entirely in Macromedia Flash and programmed with Flash's ActionScript 2.0 to allow instantaneous delivery to patients via secure intranet. The tablet PC communicates with a remote sever through XML-based web services to load current medication data, store patient information collected on the database, and download educational content on demand.

For this reason, the user interface in this study is being redesigned to work with the greater programming power, smaller file sizes, and greater delivery flexibility of Flash, but also within the constraints of delivery via intranet. Patient privacy is being guaranteed in the study through this use of a secure, intranet system. However, a longer-range goal (beyond the scope of this project) will be to deliver the program over the Internet provided that patient privacy can be fully guaranteed.

Our prior user-centered formative research with older adults elicited recommendations regarding illustration style and representation of the human figure; color; style, size and configuration of type; glare and contrast; and interactive functions such as navigation, motion, transitions, and animation speed. Our formative work in the current study has focused on visual, stylistic, and ergonomic features of alternative data-entry interface prototypes and tablet PC devices (including tablet stands, carts, and privacy screens) acceptable to older adults. Early prototypes of the data entry interface were subjected to 3 repeated sets of focus groups with 10 advanced practice registered nurses (APRNs) and 10 older adults (in two separate groups of 5) as the PEP-NG system was being developed and revised. The participating older adults were recruited from a congregate living facility for independent older adults in Willimantic, CT. Older adult participants met all study criteria and had a range of health literacy scores (6 through 10) and psychomotor skills (e.g. 2 older adults were in wheelchairs, 3 had osteoarthritis in the hands). The moderator brought up each interface feature on screen and asked the participants to share questions, comments, suggestions, and perceived difficulties with the interface design to inform successive designs.

An additional 10 older adults and an additional 10 APRN students were recruited to participate in usability studies via *individual* think-aloud sessions. The usability studies enabled iterative testing/evaluation to be executed with a sufficiently large proportion of our intervention target to help validate the usability of the software design. During the Diagnostic Think-aloud studies, subjects were instructed to verbalize their questions or problems during use of the program. Usability evaluators were allowed to prompt and answer

questions when needed but did not express any opinions or comments during the session. The evaluator/observer sat with the subject and took notes on all "positive critical incidents" (e.g., positive comments) and "negative critical incidents" (e.g., negative comments or observed inability to use the program that suggested a need for design modification) that were verbalized or experienced by the subjects as they used the interface. Videotapes from the sessions provided an opportunity for the usability evaluator/observer to cross-validate notes that captured the critical incidents. The videotaped sessions also provided a means for a qualitative analysis of subjects' mental and physical task load through observing and coding their verbal and nonverbal expressions. Subjects also completed a set of quantitative and qualitative questionnaire items—adapted from *Post Study System Usability Questionnaire* (or *PSSUQ*)—that assess perceived subject burden and satisfaction (Lewis, 2002).

After the development-phase, interface revisions were made and another 10 older adults and 10 APRN students participated in individual Verification Think-aloud studies, followed by Verification Post Think-aloud focus groups in May, 2006. Any remaining or missed interface issues were identified and integrated into the final prototype. A Beta test of the prototype was conducted during the summer of 2006 and a formal clinical trial of the program began in the Fall, 2006.

We anticipate that findings from these formative, qualitative sessions, as well as the full clinical trial of the completed program, will provide valuable guidelines for other designers and developers working in the area of interactive health interventions for older adults or other special needs populations.

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