Designing and Implementing a Web-Based Smoking-Cessation Program

by

Calvin G. Huey, MD, MPH

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CERTIFICATE OF APPROVAL

[redacted]

William Hersh, M.D.

[redacted]

[redacted]

[redacted]

Kent Spackman, MD

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Abstract

Background: Widespread implementation of smoking cessation programs is an important clinical and public health priority. Web-based patient education may provide advantages over traditional methods such as increased accessibility and personal interaction through electronic conferencing.

Objective: The goal of this study was to develop and evaluate a web-based smoking cessation program for a VA smoking cessation program.

Methods: Barriers to using the current and proposed Web-based program were assessed with an anonymous 20-question needs assessment survey. Based on the patient responses and clinical needs, the program was written. Process and impact measures (appropriateness of the content, user friendliness, and knowledge gain) were evaluated using a validated end-user survey, a task completion test, and a pretest/posttest instrument.

Results: Forty-one percent of the 97 patients answering the survey were interested in the program. Sixty percent of those interested had at least one major barrier to using the Web-based program. The program is available at http://medir.ohsu.edu/~hueyc/d5/Main.htm. A user satisfaction survey showed that 90 percent of those surveyed thought the information was appropriate in content and amount most of the time or greater. Ninety percent thought the program was user-friendly most of the time or greater. There was a slight increase in knowledge mean score after completing the program.

Conclusions: The study identified barriers to using Web-based patient education such as lack of access to computer equipment, lack of computer skills, and discomfort using a web-based program. The needs assessment identified patient-related barriers, but as the implementation and evaluation phase progressed, many institutional barriers were also identified that would prevent taking full advantage of Web-based patient education. While Web-based patient education systems show promise, both institutional and patient barriers need to be overcome prior to successful implementation.

Introduction

Overview

It is well established that smoking continues to be a major contributor to mortality and morbidity. There was a need for a Web-based smoking program at the Portland VA Medical Center because of the large demand for smoking cessation classes. Cost and personnel shortage for traditional classes made it necessary to look for other options. The Web-based program offered some advantages such as at-home learning. Previous work has suggested that CAI might be a cost-effective alternative to traditional classes. CAI may also be used as a supplement to or replacement for some of the existing classes. However, prior to developing the program, the potential barriers to and benefits of the existing program and the proposed Web-based program needed to be examined. The reasons related to both design specification and feasibility issues. Therefore, a needs assessment survey was designed and administered to patients prior to implementation. This tool was also used to gauge interest in such a program.

Once a prototype was built, the program was implemented according to specifications obtained from the needs assessment survey such as education level and input from the VA smoking cessation program staff. The Web-based program made use of self-discovery tools commonly used in many smoking cessation programs. Interactive forms were designed using Javascript and Perl CGI script.

Finally, there was a need to evaluate the Web-based smoking program. Because of limited time and resources, only process and impact measures were studied. These included user friendliness, appropriateness of content and format, and short-term knowledge gain.

Background

Cigarette smoking is the single most preventable cause of premature death in the United States. Each year, more than 400,000 Americans die from cigarette smoking. One in every five deaths in the United States is smoking related. Every year, smoking kills more than 276,000 men and 142,000 women (CDC, 1993).

In today's cost-conscious health care environment, the goals of needing to see more patients while providing good health care education and preventive services are often at odds with one another. Physicians have limited time to talk to patients about behavior modification and the importance of preventive health screening. The lack of time is a factor in poor communication. Several studies (Bjerrum, 1992; Williams, 1991; Del Mar, 1994; Kahn, 1993 a) suggest that not only does this problem exist, but also that poor communication and patient dissatisfaction are related.

A. CAI

There are many potential advantages to using CAI (Computer Aided Instruction) as compared to traditional patient education techniques. These include 1) time-savings for staff, 2) better knowledge retention, 3) multimedia capabilities (audio, video, or text), 4) increased accessibility, 5) individualized lessons, 6) consistent presentation of lessons, 7) self-paced learning, and 8) interactivity (Curless, 1987). Interactive learning has been shown to be more effective than passive textbook learning (Ohrn, 1997).

CAI was shown to be an effective teaching tool in a number of studies dealing with health care worker education (Reis, 1992; McAlindon, 1994; Napholz, 1994; Oermann, 1990; Schare, 1991; Yoder, 1993). Many studies showed that computer patient-education interventions were well accepted by patients and led to improved health status in several major areas of care (Kinzie,

1993; Kahn, 1993 b; Consoli, 1995; Ellis, 1981; French, 1983; Krishna, 1997).

B. WWW

Internet or Web-based patient education could potentially provide additional advantages such as allowing remote access while incorporating personal interaction through electronic conferencing via e-mail, chat rooms, or bulletin board services (Schneider, 1986). Web sites may become valuable clinical resources if they incorporate the most successful substantiated interactive computerized patient education techniques. There may be additional logistic advantages such as being able to update materials more quickly than CD-ROM because the provider controls and has direct access to the educational materials. Web-based presentations are also cross-platform; they can be viewed on a Macintosh, IBM, or Sun workstation.

Current problems associated with computer-assisted patient education include 1) technical sophistication required of its users (Ellis, 1981), 2) availability of computers, 3) limited financial resources or cost of systems (Lewis, 1996, Ellis, 1981), 4) limited hardware and software capabilities, 5) limited bandwidth, and 6) fear of technology. These, however, may not be problems in the future as computers become more prevalent at work, schools, public libraries, and homes. The next generation Internet will offer greater bandwidth, making true multimedia presentations on the Internet practical. Hardware costs continue to decline as hardware capabilities continue to grow.

The Internet has experienced an explosive growth in recent years. According to the MIDS third Internet Demographic Survey, the Internet has been growing at a rate of 100 percent per year since 1988 (MIDS, 1996). It is estimated that there were 26.4 million users as of October 1995. Many more patients were on-line than just a few years ago. There were vast amounts of health care information on the Internet, and new health sites were being created

continuously (Whitestone, 1996).

Previous Work

A. CAI studies

Computer-based education programs were created for a number of health subjects and purposes. For example, an interactive multimedia application was used to educate low-income women about the hazards of alcohol consumption during pregnancy (Kinzie, 1993). The author argued that educational interventions must be culturally relevant and accessible to those with low literacy levels. The computer-based multimedia program provided varied graphic displays, sound, and animation in addition to text. Kinzie's study used a pretest- posttest survey of 59 participants. In the pretest, 39 percent indicated they would select an alcoholic beverage in a social situation. In the posttest, none of the participants would select an alcoholic beverage in the same situation. The researchers found the program to be well accepted; 96 percent enjoyed using the program and preferred it to a print medium. The program provided new information and demonstrated the potential to effect change in behavioral intention without an increase in staff.

Another study (McGrane, 1990) described the advantages of using interactive media for HIV/AIDS prevention in the military community. Instead of a completely descriptive or didactic approach to STD and AIDS prevention activities, the user interacted with motion video on the screen. Interactive learning was important in modifying behavior patterns and showing their relation to the transmission of the AIDS virus.

An additional study, (Kahn, 1993 b) demonstrated the usefulness of computer-generated patient handouts in a physician's office. Information such as a new diagnosis, change in medication, exercise regimen, instruction for self-care, and follow-up recommendations were examples of important information that may be misconstrued or overlooked when given orally.

CAI also increases patient knowledge. An evaluation study of a French computer-assisted hypertension and cardiovascular risk education program (ISIS) showed that a patient's overall mean knowledge scores increased significantly after using the program (Consoli, 1995). The ISIS group had a significantly higher score than the control group. The study was a randomized control study using a pretest-posttest format with knowledge tested before and after the intervention. The standard intervention included physicians, nurses, dietitians, and the reading of pamphlets.

CAI has been well accepted by patients. This was demonstrated not only by the Kinzie study described above (Kinzie, 1993), but also in another study that described the use of a health-awareness package that included topics on coronary risk, exercise and weight management, and the effects of life-style changes on life expectancy (Ellis, 1981). A coronary risk-factor calculator calculated a person's risk for heart disease using an equation that accounted for diastolic blood pressure, systolic blood pressure, cholesterol, cigarette smoking, and body mass index (BMI). User-perceived helpfulness was based on the percentage of users of each program who felt that it was helpful for them. In this study, helpfulness was a measure of success. In all program evaluations, helpfulness was greatest for assisted users (workers at the booth actively intervened and helped the users). Unassisted users who were generally familiar with a keyboard show intermediate helpfulness levels. Unassisted users with less familiarity with keyboards reported the least helpfulness. This study has two major implications. First, if additional staff time is needed for patients to obtain maximal benefits, the use of CAI as a labor saving tool may be limited. Secondly, the intervention may best be directed to those who have familiarity with keyboards and computers.

CAI has also been used in the area of smoking cessation. The American Cancer Society created the Fresh Start CAI program (French, 1983). The program utilized a number of learning techniques such as 1) repetition of concepts, 2) positive reinforcement, 3) active student participation, 4) logical organization of knowledge, 5) learning with understanding, 6) cognitive feedback, 7) individualization, and 8) motivation. An evaluation of the Fresh Start program was conducted (French, 1983) with a convenience sample of 32 subjects. Subjects were assigned to one of three groups: 1) read self-directed study materials in parallel to the CAI group (Study materials were on smoking cessation.), 2) CAI group, and 3) control group that completed self-directed material on stress management (unrelated topic). The study supported three hypotheses. First, compared to the self-directed study groups, subjects who completed the Fresh Start CAI program learned significantly more facts about cigarettes. Second, compared to the control group, subjects who completed the Fresh Start CAI program learned significantly more facts about cigarettes. Finally, compared to the self-directed study groups, subjects who completed the Fresh Start CAI program, showed significantly more positive attitudes about CAI.

A systematic review of randomized clinical trials on the acceptability and usefulness of computerized patient-education interventions was published recently (Krishna, 1997). This study found that all but one of the studies reported positive results for the educational intervention. Some of the positive effects included increased understanding of the clinical disease and increased willingness to confide in a computer rather than a human interviewer. The topics covered by CAI programs included diabetes mellitus, asthma, hypertension, rheumatoid arthritis, urine specimen collection, medication recall, alcoholism, alcohol treatment, Health Risk Appraisal (HRA) systems, occupational rehabilitation, sexual behavior in adolescents and others.

In general, computer-based education has showed many advantages. Interactive media

can be used as a powerful tool for education. It may also be a cost-effective alternative or supplement to traditional teaching techniques because no additional personnel or time was required after development of the content (Curless, 1987). In addition, multimedia health education now has the ability to be interactive. Teaching may be more effective if the patient is actively involved rather than passively reading a pamphlet, watching a videotape, or listening to a lecture. Ultimately, patient care may benefit from improved communication and knowledge.

Typical computer programs for patient education have been didactic and failed to tailor information to an individual's specific needs (Skinner, 1993). Newer programs were able to generate individualized reports for both the patient and the health professionals based on information the patient entered. A number of programs under the category of HRA systems took patient information from a questionnaire and provided individualized reports with recommendations on what areas of health behaviors needed changing. Some of the companies that produced HRAs are: Wellsource (Clackamas, Oregon), National Wellness Institute (Stevens Point, WI), and Health Examinetics (San Diego, California).

CAI systems allow health messages to be tailored according to Prochaska and Diclemente's Stages of Change model (Skinner, 1993). Message recipients can receive different messages depending on whether they were not thinking of changing (precontemplation), just thinking of changing (contemplation), in the process of changing (action), maintaining the behavior change (maintenance), or changed but relapsed (relapse) (Green, 1991). For example, a smoker not thinking of quitting smoking or just thinking about quitting smoking could get an additional session on the benefits of quitting and the hazards of not quitting to push them into the action stage. Skinner wrote that research had shown that tailored printed recommendations for cancer screening procedures and dietary behavior changes were better remembered and

thoroughly read than standardized comparison messages (Skinner, 1993). A participant can proceed at his or her own pace. A computer can provide privacy, particularly when dealing with sensitive issues such as sexually transmitted diseases or addiction problems (Kahn, 1993 b). A patient can choose to view the educational material in a private booth versus taking a class.

B. WWW Advantages and Disadvantages

The future of computer-based patient education may lie in the World Wide Web (WWW). There are several advantages to providing health-education material on the WWW. First, there are logistic advantages. Patients do not have to be in the office to access the materials. A patient could be at home if he or she had a personal computer, modem, and ISP (Internet Service Provider) or can access it from work, public library, or school. The physician's office does not need to maintain dedicated personal computers for education purposes.

Web-based systems could also provide a degree of personal interaction with health care providers that traditional CAI could not. A patient could ask health care professionals questions via e-mail. Health care providers could answer the questions at their convenience at the end of the day or some other set time either by fax, e-mail, or phone, or they could mail the reply. Personal interaction could be achieved through scheduled chat-room meetings or unscheduled on-line sessions. While electronic conferencing is not the same as face-to-face interaction, it provides more personal interaction than going through a CD-ROM based program. The American Cancer Society has an on-line support group service that is mediated by experts. Such systems already exists for patients with HIV infection (CHESS and ComputerLink) (Schneider, 1986). Stanford's Health-Net promotes appropriate self-care and preventive activities though e-mail, bulletin board services, information and referral listings, and a self-help information library (Schneider, 1986).

Computer conferencing may be beneficial in self-help groups (Schneider, 1986). Computer conferencing allows any number of individuals to take part in a discussion even though they might be far apart. This could be a useful application among the people who form self-help groups for smoking cessation, weight loss, and substance addiction problems. With e-mail, chat rooms, and bulletin boards, messages are typed out; because only the typed messages are seen, all visual cues and nonverbal feedback was stripped away. The removal of social cues from communications could actually enhance communication (Hiltz, 1978). Participants could reread messages. They might not be distracted by social cues, but rather, would be more likely to stick to the topic. Hiltz concluded that computer-mediated discussions could reach their goal and come to a consensus as quickly as with face-to-face discussions.

Full interpersonal contact may not be necessary to change behaviors. Smoking cessation programs offered on TV or as books allow no personal interaction but were still quite popular. EIEP (Electronic Information Exchange Program) was a computer messaging, conferencing, and notebook system administered from the New Jersey Institute of Technology (Schneider, 1986). The on-line smoking cessation program permitted access to a conference of smokers trying to quit, with a psychologist participating as conference coordinator. There was interactive, personalized stop-smoking instruction. There was also record keeping, help with immediate urges, and a group progress report. Sixteen smokers took part in the pilot. Five quit for at least three months. This rate was similar to that of many face-to-face programs (Schneider, 1986). Self-help groups, such as for smoking cessation, often required patients to come together at some prearranged location. However, with the computer-based program, interactions could occur at anytime from any terminal with electronic conferencing. People who lived in rural or distant areas might prefer to use this mode of communication if they had access to a computer, modem, and

ISP.

Interactions can be anonymous. Patients would only be identified by their chosen log-ons or call names. Many individuals that participate may not want face-to-face interaction, particularly if the subject concerned a sensitive area such as addiction or AIDS. Studies have shown that patients more readily confided to a computer than a human interviewer (Krishna, 1997). A computer-conferencing self-help group did not require participants to make a public commitment to quit smoking. The impersonal aspects of computerized communication may lead some people to fear failure less, since participants never meet each other. People could provide mutual advice and share personal experiences and perceptions by computer.

The health message may be presented in a number of ways (voice, animation, video, and text). Web presentations may be designed with interactive forms and tailored to patient characteristics. Health information may be updated more easily and frequently. Vendor-supplied software required a wait for the next version.

There are disadvantages to Web-based learning as well. One major potential disadvantage is the current lack of computer skills by staff and patient. Budgets needed to purchase equipment might be limited (Lewis, 1996). CAI may be perceived as a threat by staff. There may be less personal interaction. Empathy, compassion, and the need for direct human touch and contact may not be possible with CAI. Unlike CD-ROMS, utilization of video on the WWW is limited by bandwidth. Patients may also have trouble accessing the WWW because of lack of skills, software, hardware, and ISP access with local numbers. Access to local ISPs is a problem in remote locations.

CAI can be an effective means of educating patients in health matters. Web-based health education has many potential advantages over traditional CAI. The goals of this thesis proposal

were to design, implement, and evaluate a Web-based smoking cessation program. The program was based on sound health promotion and education principles. There was a long waiting list for patients to join the Portland VA smoking cessation program. Inconvenient class times and long travel distances could be barriers to behavior change that may be remedied by such a system.

C. Learning Theories

Designing a successful smoking-cessation program, whether in CAI format or not, required knowledge of basic behavior modification theories. Some of these theories addressed predictors of success. Some studies suggest that self-efficacy and self-esteem were important predictors of success in smoking cessation (Kowalski, 1997). Self-efficacy is the internal state that individuals experience as competence to perform a desired task or behavior. Social learning theory suggested that the outcome would be dependent on both efficacy expectancies and outcome expectations (Bandura, 1977). A person must believe that he or she can accomplish the task or behavior (efficacy expectations) and that the outcome will be beneficial (outcome expectations). A smoking-cessation program should focus on skill-building (learning behavior-modification techniques) to affect efficacy expectations and education about the benefits of quitting smoking to affect outcome expectancies.

Prochaka's transtheoretical model suggested that people change their behavior over time and they go through stages. It recognized that some people might not be ready to change (precontemplators). Others may be seriously considering change but are not ready to act yet (contemplators). Others may be in the action, maintenance, relapse, or termination stage (Green, 1991). A study (Rohren, 1994) suggested that Prochaska and Diclemente's action stage and low Fagerstrom Tolerance Questionnaire score (< = 6) were also predictive of successful quitting. The Fagerstrom is a questionnaire and scale used to measure physical dependence on nicotine.

Goals

The primary goals of this study were to successfully design and implement a Web-based behavior modification program in the area of smoking cessation. The secondary goal was to integrate this intervention into the multimodal smoking cessation program that currently exists. A multimodal program is one that included educational, counseling, and pharmacological therapies.

The specific aims of this study were to:

1. Assess the patient-related barriers to behavior change posed by the current smoking cessation program as well as those to using a Web-based cessation program.
2. Design a Web-based smoking cessation Web site.
3. Implement the Web-based program for a trial period.
4. Evaluate acceptability, content, ease of use, and format of the program.
5. Determine if using the program can increase knowledge.

Table 1 lists the research questions asked, objectives met, and methods.

Table 1: Research Plan

Research Questions	Objectives	Methods
Phase 1: Were there time and distance barriers for VA (Veterans Administration) smoking cessation program patients? Were there self-perceived computer-skill and equipment-access problems with using a CAI tool? Were patients comfortable with a smoking cessation program in computer format? Did patients have a high self-perceived need for personal attention? Were patients interested in using such a program?	Collect a convenience sample of needs assessment surveys during a three-month period.	Gave an anonymous 20-question needs assessment survey (See appendix 1) to a convenience sampling of all VA patients attending the usual smoking cessation Class 1 between 09/24/97-1/07/98.
Phase 2: Develop a user-friendly Web-based smoking cessation program.	Complete the program itself. The content will be approved and reviewed by the VA staff. Debug any problems identified.	Used the spiral rapid-prototyping life cycle. The program was developed using HTML, Javascript, and Perl CGI.
Phase 3: Was the program's content appropriate? Was it user-friendly? Did patients gain knowledge?	Evaluate the appropriateness of content and user-friendliness of the program. Evaluate the amount of knowledge gained from the program.	Used a validated user-satisfaction survey and a pretest/posttest knowledge quiz. See Appendix 4.

Methods

Phase 1: Needs Assessment/Requirements Analysis (See Appendix 1-Survey)

Behavior Change Model

Based on Rosenstock's Health Behavior Model (See Appendix 2.), the likelihood of a patient following a recommended preventive health action is a function of the difference between perceived benefits and perceived barriers (Rosenstock, 1988). The current smoking cessation program offered the advantage of more personal interaction, but the barriers were that class times were limited or patients had to travel long distances. The benefits of a computer-based system may be convenience i.e. patients may come in at any time or access it at home, work, or school. However, there were drawbacks and barriers such as less personal interaction, patients not having the computer skill or equipment to access the program being at places other than the clinic. The survey's purpose was to assess some of these factors.

Survey Design and Administration

We used an anonymous 20-question survey to assess:

- Patient computer skills
- Patient attitudes toward using computer-based education
- Barriers and benefits to using the current program
- Patient demographics

The smoking cessation staff at the Portland VA reviewed the questions prior to use. To encourage participation, the survey was kept short and anonymous.

The survey was administered to all VA OPC (Outpatient Clinic) patients in Class 1 of the smoking-cessation program for a six (July, 1996-January, 1997)-month period. The survey was included as part of the intake packet that all patients completed. The survey was administered and collected by the class instructors. The survey was designed primarily to assess receptivity and

feasibility of using a Web-based smoking-cessation program.

Phase 2: Design and Specification Phase

Educational Design

A. Learning and Behavior Modification Theories Used

The program utilized several common learning and behavior modification principles. The first principle was education and awareness building. The benefits of quitting and the harm and risk posed by smoking were presented to precontemplators and contemplators. The next principle used was repetition of concept. Key behavior modification concepts were repeated throughout the program. The user could repeat sections that he or she felt needed additional work. Active participation was another key education principle used. The user could control the flow of the lessons. Hypertext allowed the user to jump ahead or back depending on his or her interest. Although there was a sequential progression to the lessons, the user could bypass this and go to the table of contents. There were exercises and questionnaires that the user filled to discover more about his problem with smoking. Learning materials were individualized. Depending on how the user answered the questionnaires, individualized information was presented.

Another important principle was a logical organization of knowledge. The lessons were grouped by topic into two classes. The benefits of quitting and the harm and risks posed by smoking were presented to precontemplators and contemplators. Once a person reached the action or maintenance phase, the person was presented with a stop-smoking contract. This tool was used to solidify and reinforce the person's commitment to quit. Class 1 was primarily designed to get the quitter to learn more about his or her smoking problem. It also gave the quitter the tools he or she needed to cope with roadblocks such as triggers and urges. Classes 1 and 2 dealt with specific problems that might interest the quitter. These included stress

management, benefits of exercise and its use in smoking cessation, and dealing with issues related to weight gain and smoking cessation. Class 2 also presented material related to the role of nicotine replacement therapy. Hopefully, the heavy smokers used these techniques to cut down to one pack per day (ppd) prior to beginning nicotine replacement. Patients who wanted nicotine replacement therapy could use the Table of Contents to skip to this section. A Web resource to help one quit provided links to organizations that provide smoking-cessation programs or support groups such as Nicotine Anonymous.

Motivation was another key educational concept used in the program. The program included material dealing with self-reward and positive reinforcement. The program content also included a section dealing with knowledge and skill building. The information and exercises presented were designed to build such knowledge and skills.

B. Self-evaluation Instruments Used

The program included many personal assessment tools to help the quitter identify his problem areas. Well-accepted instruments used in many smoking cessation programs were incorporated into this program, including:

Stop-Smoking Contract: Goal-setting was important. Tools such as the stop-smoking contract helped the quitter solidify his goals. These contracts are used in many smoking cessation programs.

The Smoking Log: Monitoring was key to behavior modification. The smoking log was designed to help a quitter monitor his behavior. It also helped him or her build problem-solving skills. Relapse-prevention skills were necessary to keep the patient smoke-free after quitting.

Why I smoke?: This questionnaire was adapted from the American Lung Association's

Freedom From Smoking Program. The "Why I smoke?" questionnaire and the stop smoking log were tools used help the quitter identify problems areas and triggers.

Prochaska and Diclemente's Stages of Change Questionnaire: Prochaka's transtheoretical model suggested that people change their behavior over time and they go through stages. It recognized that some people might not be ready to change (Precontemplators). Others may be seriously considering change but are not ready to act yet (Contemplators). Others may be in the action, maintenance, relapse, or termination stage. Depending on the stage, different messages may be presented (Green, 1991).

Fagerstrom Nicotine Dependence Scale: This instrument was used to assess physical dependence.

Stress Test: This was adapted from the Kaiser Permanente Stop Smoking Program by Geoffrey Willcher, 1996.

Fitness Scale: This was adapted from the Kaiser Permanente Stop Smoking Program, 1996.

Program Design

A. Developmental Life Cycle Model

The spiral method of quick prototyping, which was based on principles of incremental development, was used for the Web-based smoking cessation program. Each loop included requirements analysis, design, implementation, and validation (Degoulet, 1997). At the end of each loop, a new version of the software was produced. New functions and features were added at each increment.

B. Materials and Software

The program was written using an HTML editor. The Web pages were created with

Corel Web Master Suite v1.5 by Macromedia (San Francisco, CA) and Claris Home Page v2.0 by Claris Corp. (Santa Clara, CA). Programming languages used included Javascript and Perl CGI. The program source code is accessible at medir.ohsu.edu/~hueyc/d5/Main.htm. Perl and Javascript were used to process interactive form information. Javascript was chosen because it was an easy-to-learn programming language. Certain effects such as creating bar charts required CGI programming. The pages were maintained on a UNIX-based Web server located at Oregon Health Sciences University (OHSU).

C. Interface Design and Functionality

Navigation in the program occurred in two ways (serially forward and backward and non-serially from a Table of Contents). This was designed to give patients more options in choosing how they wanted to access the materials. See Appendix 3 for site map. The pages used small animated GIFs to accentuate points and digital Real Audio ™ files for audio reinforcement. Real Publisher™ by Real Networks (Seattle, WA) was a program used to create and listen to streaming audio. A WAV file (audio file format) did not need to download entirely before being played. This saved time for the user. A user obtained organ-specific risk of smoking by clicking on various locations on a large image map of the human body. The advantage of these systems included accessibility outside of the clinic and usability on both Macintosh and Windows machines.

Implementation Plan

A. Content and Workflow Assessment

A workflow assessment was performed to determine how the Web-based smoking cessation program was to be integrated with the Portland VA smoking cessation classes. The workflow assessment involved interviewing the health educators, pharmacist, Patient Resource

Center workers, and Dr. Linda Lucas. The program was demonstrated. The best ways to implement the program with minimal disruption of the current workflow were discussed.

Dr. Lucas and health educators working under her direction evaluated the program content to determine appropriateness and match to the current program. The ease of use and clarity of the language were also assessed. Adjustments were made based on the feedback.

C. Resource Assessment

There were many resource limitations in the clinic. There was only one computer available. This was one of the reasons for choosing a Web-based format. Patients could access it at home if they had access to a computer, modem, and ISP. No full-time educator was available to train the patients. Instructions were included on the Web site and written documents were provided. No budget was dedicated to the project. Most programming and evaluation was done by the researcher.

Phase 3: Evaluation

Survey Design

The evaluation study utilized a pretest-posttest design with descriptive and analytic components. No identifying data such as names, medical record numbers, SSN, videotape or audio tape were collected. Several filtering variables were collected. These included: 1)self-perceived computer skills, 2) user-rated computer program usability, 3) user-rated computer program content appropriateness, and 4) user-rated computer program format appropriateness.

Impact variables measure immediate effects of a program. Examples of impact variables include change in attitude and increased knowledge (McKenzie, 1993). The primary-impact variable used was increased knowledge. Increased knowledge was measured by change in pretest and posttest knowledge scores.

Statistical issues

The null hypothesis was that there is no difference between the pretest score and the posttest knowledge scores. Assuming the subjects had a pretest knowledge score of 30 percent and a posttest knowledge score of 60 percent, the sample size needed was 15 (power=80 % and alpha error=0.05). The goal was to recruit ten to 20 subjects for the pilot test. In order to establish a significant difference between pretest results and posttest results with a reasonable power, a large difference in the pretest and posttest results was needed. For this reason, the knowledge test was designed to be difficult by reducing the effect of the tester's preexisting knowledge level on the pretest-posttest knowledge scores. Each question had four possible responses; there was a 25 percent probability of guessing an answer correctly. The ten knowledge questions were tested on several subjects with an average score of 30 percent correct. The ten questions were randomly assigned to either the pretest or posttest. This accounted for the testing

bias resulting from familiarity with the test questions when both the pretest and posttest contain the same questions. The following formula (Pagano, 1993) was used to estimate sample size for two proportions:

$N=\{[Za*SQRT(P_0(1-P_0))+Zb*SQRT(P_1(1-P_1))]/(P_1-P_0)\}^2$, where

P_0=hypothesized population proportion
P_1=alternative population proportion
N=sample size
Za=Z value of α error (probability of committing a type 1 error)
Zb=Z value of β error (probability of committing a type 2 error)

In addition, a short eight-question survey was used to access three factors: Content, Format, and Ease of Use. The evaluation instrument was a validated scale. The internal consistency (reliability) within a set of questions (i.e. content) was measured with an alpha coefficient (Doll, 1988). Table 2 outlines the factor each question measured.

Table 2: End-User Computing Satisfaction Survey Questions

Questions	Factor	Scale
C1: Does the system provide the precise information you need? C2: Does the information content meet your needs? C3: Does the system provide reports that seem to be just about exactly what you need? C4: Does the system provide sufficient information?	Content (coefficient alpha=.89)	1=Almost never 2=Some of the time 3=Almost half the time 4=Most of the time
F1: Do you think the output is presented in a useful format? F2: Is the information clear?	Format (coefficient alpha=.78)	1=Almost never 2=Some of the time 3=Almost half the time 4=Most of the time
E1: Is the system user-friendly? E2: Is the system easy to use?	Ease of Use (coefficient alpha=.85)	1=Almost never 2=Some of the time 3=Almost half the time 4=Most of the time

(Doll, 1988)

Survey Administration

The subjects were Portland VA OPC-Smoking cessation clinic patients consisting of smokers who wanted to quit. A convenience sample of self-selected volunteers was taken between June-September, 1998. The study posed minimal risk to the patients. Patients gave consent to the OPC Patient Resource Center staff.

Patients who came to the first class meeting of the current smoking cessation program were asked by the health educator if they would like to volunteer to evaluate a computer-based smoking cessation program. The patients were told that this was voluntary; patients could quit anytime and continue with the normal smoking cessation program. The volunteers were asked to complete a pretest smoking-knowledge questionnaire. The volunteers were then seated at a terminal and given a survey. The survey asked the patients to complete a number of computer navigation tasks and to review the material. Patients completed the survey and the posttest knowledge test after completing the computer program. See Appendix 4 for questions.

Results

The results of the needs assessment survey were summarized in the first section. This phase focused on the demographics and barriers of both the present and proposed Web-based smoking-cessation program. The design and programming phase results are illustrated with screen captures and code segments in the second section. Finally, the results of the evaluation study are presented.

Phase 1: Needs Assessment

Demographics

A. Age

The demographic characteristics of the patient population had vast implications on how our system was implemented. Considering our survey, a large majority of the patients were over 40 years of age (88.1 percent). It was expected that older patients would be less familiar with computers and less interested in taking the class in computer format. The average age of patients interested in taking the class was 49.7 years; the average age of those who were not interested was 56.1 years. A t-test for independent samples was significant at $p<0.05$ ($p=0.009$) at equal variances. The independent t-test result may differ because the two samples had different variances. Levene's test was used to test the significance of the difference in the variance (Pagano, 1993). Levene's test indicated no significant difference ($p=0.884$) in the variances of ages of those interested in the program versus those not interested in the program. In order for the t-test results to be valid, the assumption of normality must be met. Several statistical tests were used to determine this. The assumption of normality using Shapiro-Wilkes test was verified with a significance of $p>0.05$. This was used because the sample size was less than 2000. This meant the data were not significantly different from a normal distribution at the alpha error=0.05 level. Box

plots showed no obvious outliers that may have skewed the results. Both histograms (for those who were interested in taking the program in computer format and those who were not), though slightly skewed to the right, approximated a normal distribution. The significant age difference between the two populations may have important implications; this may indicate that interest in taking the course in computer format may grow in the future as a new age cohort enters the VA system.

B. Race

The racial characteristics of the patient population were 89.1 percent white, 4.3 percent black, 2.2 percent Native American, and 4.3 percent other. The vast majority was white. Racial diversity did not seem to be a major factor in this group. One patient classified himself as both white and Native American. He was classified as "other," since no predominate racial identity was offered.

C. Gender

The gender distribution was 10.9 percent female and 89.1 percent male. This was expected, given that the institution under study was the VA. A significant percentage of patients were interested in the program in computer format. Forty-four percent of those who answered the question were interested in taking the course in computer format, excluding the 6 (6.2 percent) surveys that had missing or ambiguous data for that question (one checked both boxes).

D. Patient Education Level

The highest education levels of those taking the survey are summarized in Table 3. Ninety-two percent of patients interested in the Web-based program had a high school education or higher (See Table 3). To ensure that the material was understandable to the most patients without sounding condescending, all materials were written at the eighth grade level.

Table 3: Educational Level

	All Surveyed (N=97)	Those Interested In The Web Based Smoking Cessation Class (N=40)
Elementary school	3.2%	0%
Jr. high school	4.3%	7.5%
High school	44.1%	37.5%
Technical	12.9%	10%
Two- yr. associate	20.4%	30%
Four- yr. college	10.8%	10%
Masters	1.1%	0%
Doctorate	3.2%	5%

Patient Barriers to Class Programs

A. Distance:

Those traveling over 40 miles to come to the clinic comprised 23.7 percent of those surveyed. If one assumed that the VA had an older population, then this may be a particular problem since these patients may have difficulty in driving long distances due to diminished visual acuity, reflexes, hearing, other diseases, and disabilities.

B. Timing of Classes

For at least 27.8 percent of those surveyed, timing of the classes was a problem. Forty-four out of 97 (42.4 percent) surveyed had said they either had problems with the class times and/or had to travel greater than 40 miles to come to the class. This suggested that there was a substantial proportion of patients who may have wanted to use the computer system, their number closely approximating the proportion of those surveyed who stated they were interested in using the program in computer format. The next step was to examine the barriers to using such a system to get a better estimate of the proportion of patients that may actually use it.

Patient Barriers to a Web-Based Program

A. Patient Lack of Computer Equipment

Lack of computer access represented a major barrier to using the Web-based smoking cessation program via remote location. The survey results showed that 46.4 percent of those surveyed did not have access to a computer. Even among those that were interested in using a Web-based smoking cessation program, 30.0 percent did not have access to a computer. The implication of this for the clinic was the need to maintain one or more clinic personal computers for the program.

In order to access an ISP, some sort of modem was needed. Only 55 percent knew for sure

that they had access to a modem. Again, this was an equipment-related barrier to using a Web-based smoking cessation program. This did not address the issue of access to an ISP or the knowledge needed to operate the software. This may not be an issue if the patient was able to access the Internet from work or local public library.

Even among those interested in the class, there were substantial barriers. Thirty percent did not have access to a computer. Many (37.5 percent) did not have access to a modem or didn't know what a modem is.

B. Self-Perceived Patient Computer Skills

In addition to the lack of equipment, self-perceived lack of computer skills was a barriers to using a Web-based smoking cessation program. Only 51.5 percent of those surveyed had previously used a computer. As expected, a greater proportion of those who were interested in using the Web-based smoking-cessation program were computer users (77.5 percent); this still meant that 22.5 percent were non-users. Among those interested in the Web-based program, 50 percent were self-perceived beginners or non-users and almost half (47.5 percent) did not know how to use a browser or did not know what a browser was.

C. Patient Attitudes about a Computer Based Smoking Cessation

Many (27.5 percent) were uncomfortable to very uncomfortable with a smoking cessation program in computer format. It was also significant that even within the group interested in using the program in computer format, 17.5 percent were uncomfortable or very uncomfortable with the idea of taking the smoking cessation program in computer format. This may indicate that despite their discomfort, they might be willing to use this medium because of other advantages such as convenience. An alternative solution for this may be to increase the number of classes offered. Although the computer format may not be the optimal solution for such users, they may be willing

to try it. It may also mean the users may need more hand-holding from the staff. That may adversely impact resource consumption. However, this remains a significant barrier to implementing such a system.

The subject's self-perceived need for personal attention may explain negative feelings toward using an impersonal medium such as computer based education. Most patients (75 percent) needed at least moderate levels of personal attention from a health care professional to quit, and 20 percent needed a great deal of personal attention. However, there was no statistically significant association between the odds of a patient saying he was interested in using the computer smoking cessation program and the degree of attention he felt he needed (Chi square for linear trend=0.544, p value=0.46). The test was used to detect a dose response effect in categorical variables (ordinal and nominal). All assumptions of the test (no cells contain 0 and no more than 20 percent of cells have values less than 5) were met. This does not rule out a confounder that may mask the association. For example, a patient's desire to have the patch the same day may temper the effect of decreased personal attention on the person's desire to use the program. One might predict that those who need more personal attention would be less likely to use a more impersonal medium such as a computer. Most (70 percent) preferred to work by themselves rather than in a group. This question targeted the ability of patients to use a self-help program. Based on this information, it would be prudent to include the computer class as a supplement or replacement for a portion of the smoking cessation class but still have the option for the patient to see a health-care provider when needed for support. It may also be necessary to provide some computer training to approximately half of the potential users.

D. All Barriers to Using a WWW Based Smoking Cessation Program

Sixty percent of patients interested in the program had at least one of the following potential barriers to using a Web-based computer smoking cessation program:

- Lack of access to a computer
- Non-user
- Lack of access to a modem
- Non-user of WWW, or didn't know what the WWW was
- Self-perceived beginners or non-computer users
- Need maximum personal interaction to quit
- Uncomfortable with computer format of class
- Uncomfortable with using computers

Phase 2: Design and Programming

Program Specifications

At a March, 1998 meeting with the VA PRC staff and health educators outlined the functionality and integration of the Web-based program. The agreed-upon purpose of the smoking-cessation computer pilot was to provide same-day service with less intense resource use of counselors and pharmacists.

The computer program was designed to reinforce concepts by repetition (first using the computer program, then using review questions given by the pharmacist). The long-term goal was to provide this service at the patient's home or library. The program may be used center-wide if the pilot proved to be customer and program friendly as well as resource sparing; VISN (the regional VA government) made it clear that there must be increased access to smoking-cessation programs.

Upon reviewing the program, the following comments and suggestions were made. The participants generally liked the program. They particularly liked the interactive nature and the immediate feedback the program allowed. The Web-based program was broken into two classes to correspond to the two classes that currently exist. Upon discussion, the need to bring in a second PC and network line for the Patient Resource Center (PRC) at the Outpatient Clinic was brought up. At the time of the study, the PRC had only one machine (a PC) that was used for

other patient education purposes. There was a concern that patients may spend too much time on this machine for the pilot and prevent its use for other purposes.

There was also a concern that textual information was not sufficient for patient understanding. It was suggested that an audio tape dealing with the basics of the behavioral counseling be created to go with Class 1 and Class 2. There were several alternatives. Providing the audio directly from the Web page (wav files) may have created patient frustration with the system because of long download times. There was also the problem of the limited computer resources at the PRC. Providing audio on-line would result in the patient sitting at the terminal for a longer period of time. The audio tape could be turned on at prompted locations on the Web page. The patient could leave the workstation to listen to the tape and free up the workstation for other uses. The program would show prompts for the patient (e.g., LISTEN TO AUDIO TAPE NOW.) within the Web pages at the end of each lesson. In addition to the audio tapes, the issue of providing patient handouts was brought up. Handouts for Class 1 and 2 needed to be given to pilot patients for home reinforcement. The issue of training was important. Even though the meeting participants agreed that the interface was simple to use, in-services on use of the Internet smoking cessation program needed to be given to the four staff members in the PRC.

The issue of program integration and workflow was discussed. Patients selected would be offered the class to opt for same-day service, using this pilot. Patients were only be asked to participate between 9:00 a.m. and 2:00 p.m. Monday through Friday, when the Resource Center was open and staffed. A yellow "Prescription for Education" form would identify the patient for the pilot. The Resource Center staff would help patients with the Internet program and with the audio tape as well. After completing Class 2, the patient would go back upstairs and meet with the clinical pharmacist. The pharmacist would develop a checklist to review the basics and see how

much the patient actually learned from the pilot program. He would then reinforce the information. The clinical pharmacist would write a prescription for Nicotine replacement to be filled in the pharmacy, sending the patient to the smoking cessation nurse for follow up telephone appointments. The staff did not accept the idea of a chat room. Their principle concern was that this would create additional work for the staff, rather than reduce it.

The program algorithm contains the following steps:

"Why I smoke?": Questionnaire adapted from the Freedom From Smoking Program: six types of smokers (1. stimulation, 2. handling, 3. relaxation-reward, 4. stress reducer, 5. craving, and 6. habit). If the score for a category is >=11 then the user will get tips to deal with that particular problem.

Prochaska and Diclemente's Stages of Change Questionnaire: There are four categories: precontemplation, contemplation, action, and maintenance. The results are based on highest score. Those who score in "action" or "maintenance" are taken directly into the program. Those who are in "contemplation" and "precontemplation" stages get an additional health message on the benefits of quitting and the risks of smoking.

Fagerstrom Nicotine Dependence Scale: Those with scores at >=7 are given the message: You are likely to have withdrawal symptoms.

Stress Test: Adapted from the Kaiser Permanente Stop Smoking Program by Geoffrey Willcher, 1996. Scores between 20 and 40 indicate low level of stress, scores between 41 and 60 indicate a moderate level of stress, and scores between 61 and 80 indicate high levels of stress.

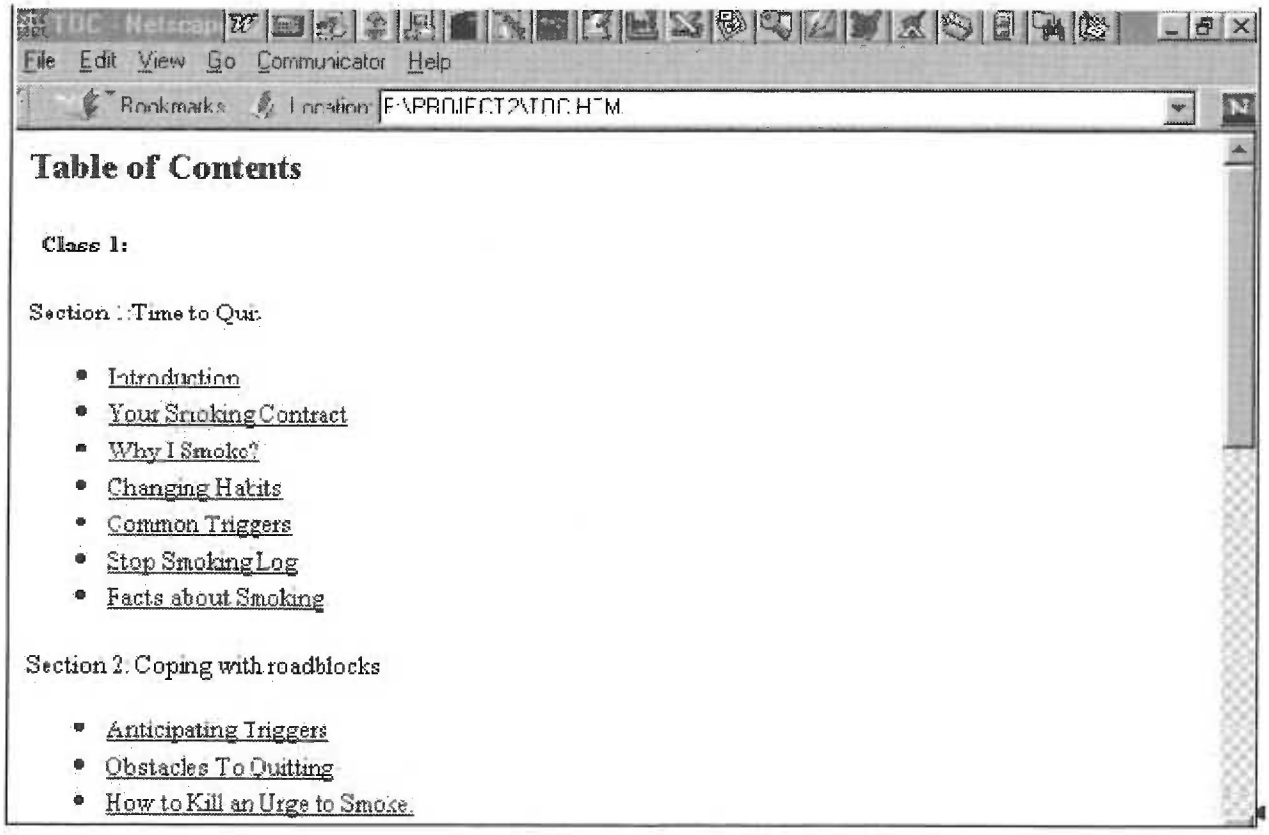
Fitness Scale: Adapted from the Kaiser Permanente Stop Smoking Program by Geoffrey Willcher, 1996: scores 13-15 (Congratulations! Maintain your present level of activity), scores 8-12 (You are moderately inactive and should increase your level of activity), and scores 7 or less (Begin planning an exercise program now!)

See Appendix 3 for the program flow diagram.

Program Interface Design

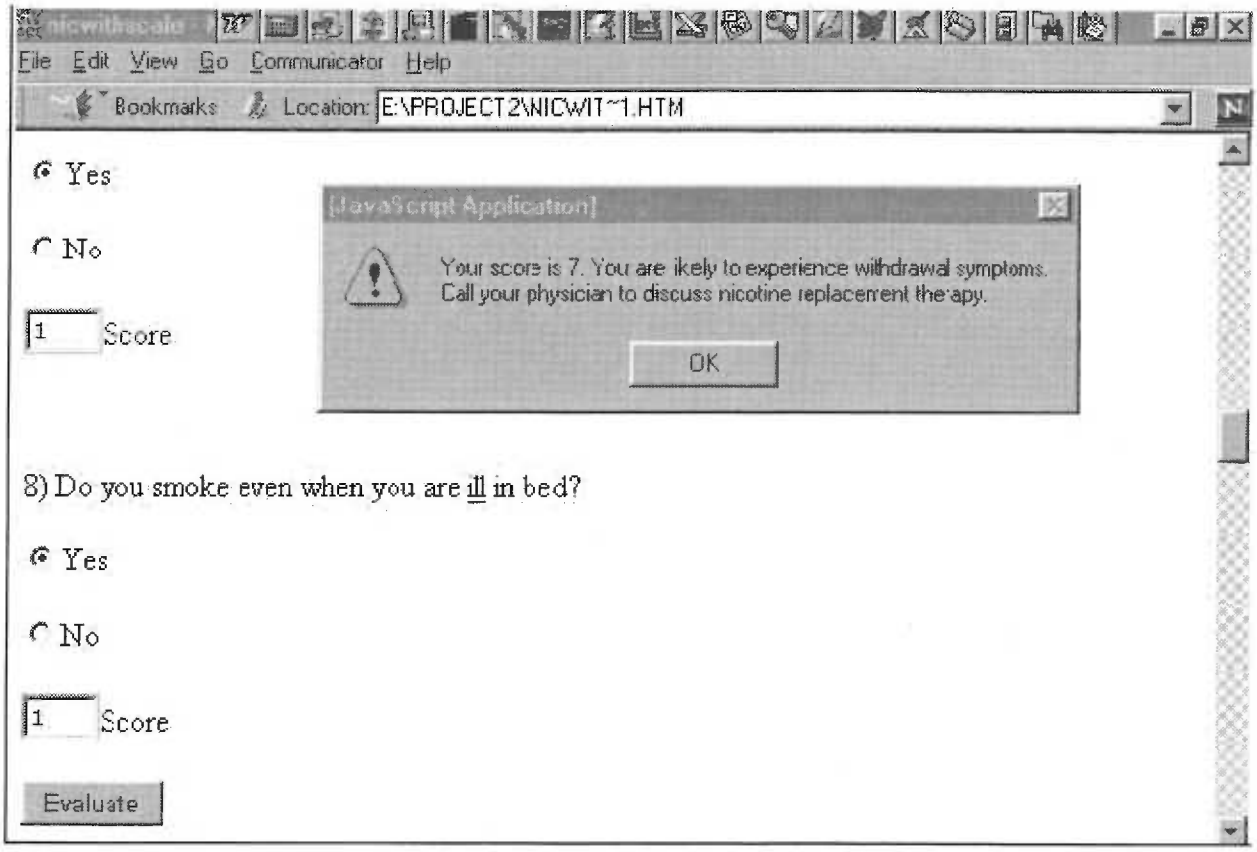
The program focused on behavior modification techniques. A table of contents was developed so patients can access information in a non-serial manner (See figure 1).

Figure 1: Table of Content Page



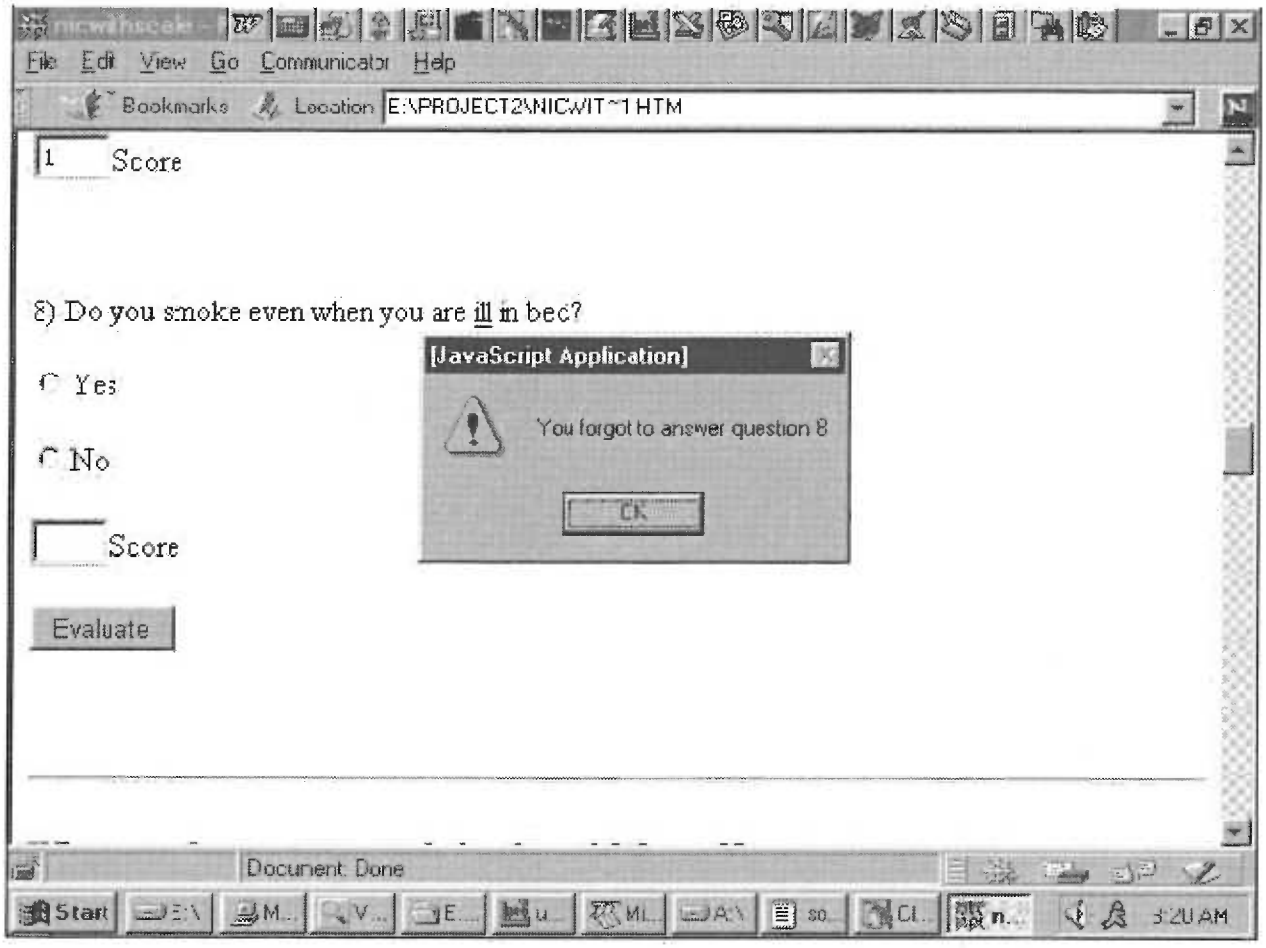
Javascript was used on some forms to process information and return user-specific information. (See source code in Appendix 5). The information was displayed with message boxes (See Figure 2).

Figure 2: Javascript Patient Feedback Message Box



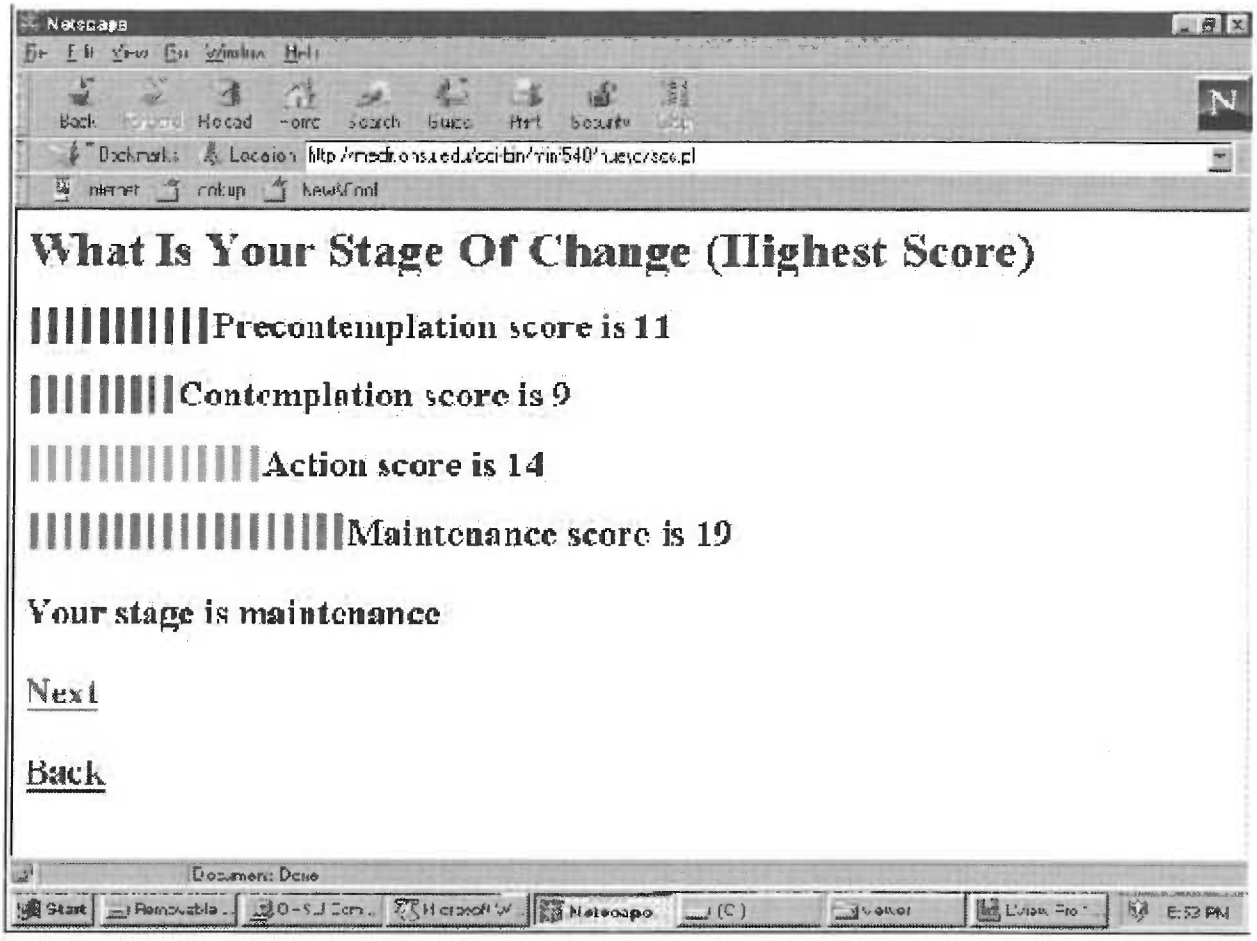
The program checked the forms to make sure all questions were answered and returned an error message if they were not (See Figure 3).

Figure 3: Data Validation



The program used Perl to process the Stages of Change form (See Figure 4). It provided graphical feedback using a bar chart. See Source Code in Appendix 6.

Figure 4: Bar Chart for Graphical Patient Feedback



Phase 3: Evaluation

The skill levels of those who volunteered to use the Web-based smoking cessation program were assessed, using a self-report instrument. Six questions were asked that assessed computer user abilities and skills (See Appendix 4). The higher scores should corresponded to higher user computer skills. One point was given to each affirmative answer. Only ten percent of the patients had no computer experience. Twenty percent scored 4 of 6; 20 percent scored 5 of 6; and 50 percent scored 6 of 6.

User-friendliness was measured with a task completion test. Patients were asked to perform a task. These included the following:

1) View the instruction page.
2) Fill-out and use the Stages of Change Questionnaire.
3) Navigate forward and move to the next page.
4) Go to the Table of Contents

A total of 90 percent completed all four tasks, and ten percent completed three of four tasks.

Although there was a slightly higher mean score in the posttest (2.2) compared to the pretest (1.5), the difference was not statistically significant. A non-parametric test (Wilcoxin sign rank test) was chosen because of the limited number of possible scores a patient may receive on the pretest and posttest. The possible scores ranged from integer values 0 to 5. The lack of statistical significance may have been due to low power (.0865) resulting from low sample size. Table 4 shows the results of the end-user satisfaction survey. Table 5 shows the comments patients made about the program.

End-User Satisfaction

Table 4: End User Satisfaction Survey

Question	Almost never	Some of the time	About half the time	Most of the time	Almost Always
Does the system provide the precise information you need? (N=10)		10%*		70%	20%
Does the information content meet your needs? (N=10)		10%*		50%	40%
Does the system provide reports that seem to be just about exactly what you need? (N=10)	10%*			70%	20%
Does the system provide sufficient information? (N=10)	10%*			40%	50%
Do you think the output is in a useful format? (N=10)	10%*		20%	40%	30%
Is the information clear? (N=10)	10%*		10%	40%	40%
Is the system user friendly? (N=10)	10%*			50%	40%
Is the system easy to use? (N=10)	10%*			50%	40%

*First patient user prior to process and program modifications

Table 5: Qualitative data from Patient Comments

Pt	Likes	Dislikes	Change
1	Content: Liked explanation of alternative approaches	Location: Noisy, distractions	Create a quit room
2	Content: Easy to read, quick to get through	Didn't like computers	Nothing
3	Content: Informative	Nothing	Wouldn't
4	Content: Easy to understand	None	None
5	Content: self paced	Content: Confusing at times	Don't know
6	No comments	No comments	No comments
7	Well laid-out and informative	Questionnaires (computer) difficult to understand. Some answers in the program to fit own answer	Make some of the questions easier to understand and some answers not so extreme
8	Clear pages	Semantic loading of questions. Assumption of competency with Web pages	
9	No comments	No comments	No comments
10	Convenience: people can come and do classes any time	Needs better organization and presentation. Less skipping around between computer and printed material	Make it more interactive rather than rework written forms and presentation

Discussion

The results of the needs assessment survey showed that there were substantial barriers to using the existing classes. Forty-two percent surveyed had problems with class timing and distance to class. There was also some promise that a Web-based smoking cessation program might work; 41 percent of all surveyed had expressed interest in the Web-based program. However, 60 percent of those that were interested had at least one barrier to using the Web-based system.

The goal of the second phase of this thesis was to design an well-integrated, user-friendly program with good content. The VA staff wanted to first try the program in the clinic. This created a number of difficulties. The lines were slow because Internet content had to first go through a firewall located in San Francisco. The equipment was old (486 66MHz PC). The interface was optimized for speed. This meant a reduction in graphical elements and a focus on text for quicker loading. Since the machine in the clinic had no multimedia capabilities, audio tapes had to be used. The patient accessing the material from the Internet can access Real Audio™ files with the same content that was in the audio tape. Because patients had only a limited amount of time on the terminal, extensive browsing of external stop-smoking sites was not feasible. To avoid patients' accidentally checking multiple answers, option buttons were used exclusively. For the form to be scored correctly, all questions had to be answered. A Javascript program was created to ensure that all the questions were answered first before scoring.

The computer program appeared to be user-friendly. Most of the users, 90 percent completed four out of four tasks, and ten percent completed three out of four tasks. However, since these data were derived from self-report data, the conclusions were limited by a self-report bias. Subjects may report better-than-actual performance for fear of embarrassment at not being able to accomplish all the assigned tasks. A control group may sort out this problem to a degree. However, anticipating difficulty in recruiting subjects, a control group was not used. The control could have been derived from those taking the standard intervention.

The current smoking cessation intervention consisted of two classes. The first class dealt with behavior modification and the benefits of quitting. The second class dealt with pharmacological therapies. If the patients were given pharmacological therapy, this also included a six-week period of telephone follow-up. Continued pharmacological therapy hinged on the condition that the patient was compliant with the telephone follow-up. Otherwise therapy ended. Directly measuring keystrokes could solve the problem of self-report bias. However, that technology was not available at the time of the because of its expense. Another way of dealing with this problem was to conduct a pilot study with the target population. This study served as that pilot. Using multiple measures was another technique to enhance the accuracy of self–report data. We also used the end-user satisfaction survey as an additional measure of user friendliness. Those results roughly correlated to the task-completion results. The system was user friendly; 90 percent of those surveyed ranked the system user-friendly and easy-to-use most of the time or to a greater extent.

Based on the end-user satisfaction survey results summarized in Table 4, one can also conclude that the information content and amount were adequate. Ninety percent of those surveyed said the information content and amount filled their needs most of the time or more.

The format of the output and the information clarity required some work. Based on subject comments summarized in Table 5, the program needed more interactivity, and the Web pages needed to be broken into smaller segments to reduce scrolling. This was difficult to do with long forms. The other problem seemed to arise from the wording of the questionnaires. Even though the forms were instruments commonly used in other smoking-cessation programs, they confused some patients. One patient remarked that the question options did not have a choice that reflected his true feelings.

There were number of other design issues that needed to be addressed. Five of the ten subjects were directly observed. These subjects tended to navigate in a linear fashion. The subjects tended to use the next and previous page links primarily except when prompted to do otherwise as a task. This seemed to be caused by the layout of the page. The Table of Contents button was located at the bottom of the page below the next and previous page link. This may not have been in a convenient location. A frame with the Table of Contents links on the left side of the page may promote a more non-linear use of the program.

One patient had asked for a chat room for social support. Another had said chat rooms would not be useful because there were never enough people in the rooms. If the page prompted patients as to the time to get on-line, then everyone wanting to participate would be on-line at about the same time; this would eliminate the problem of inconsistent log-on times. Of course, these sessions would not be moderated, because VA staff had no desire to participate, given time pressures.

Another interface change would be to remove the actual score returned by the evaluation instruments. This could promote a desire to game the system; the subjects could continue to fill out the forms to improve their scores. Using an on-line log-on name-patient id, date, time, and on-

line recording of the results, one could tell who was gaming the system and who was not, because multiple data submissions would be recorded on the server.

The knowledge instrument showed a slight increase in scores but it was not statistically significant. This was most likely a result of the low sample size (N=10). The questions asked on the knowledge test instruments may also have been trivial to the patients. A knowledge test that focused on more commonly known information may also produce uniformly high scores with little distinguishing characteristics. The challenge was to find relevant questions that were not commonly known. The patients did not use the program in the optimal fashion; the subjects were not able to review materials repeatedly because of time limits. A debriefing with the pharmacist revealed further doubts as to the amount of knowledge students gained.

Although this thesis failed to answer the question of whether patients gained knowledge from a Web-based smoking cessation program, it did illustrate clearly the limitations of traditional CAI. There were many problems related to timing and scheduling patients on the computers. There were space and privacy problems. The PRC was an open room, so multiple patients were in the room at once and there were no dividers in the room. In addition, there were workload strains on the PRC staff. If this project was to be redone, the program should be implemented as a remote-access program. Patient access and recruitment would be improved. Institutional constraints, particularly the fear of a massive increase in demand for service due to greater access, led to this restricted implementation.

The usefulness of Web-based health education, although promising, was limited because of these barriers. Although many studies have cited the usefulness of features such as e-mail (Schneider, 1986), privacy, possibility for a participant to proceed at own pace, and use of audio/video (Curless, 1987), this study was hampered by institutional policies, lack of funds for a

high performance multimedia computer, lack of staff, poor facilities design, and workload issues. For example, this had an adverse effect on the pharmacist's workload. Both the off-site and on-site implementation would increase the pharmacist's workload. The traditional class format allowed the pharmacist to see all the smoking-cessation patients in one day. The computer format, while making things more convenient for the patients, made it more inconvenient for the pharmacist since she had to consult each patient; these patients might show up almost anytime during the scheduled hours. The workload also shifted from one of the health educators giving Class 1 to the PRC staff. The web site also required someone to maintain and update the pages. Increased demand for smoking cessation may also lead to greater pharmacy cost. The statement made by one researcher (Curless, 1987) that computer-based education could be cost-effective because no additional personnel time was required, should be qualified by the questions "Whose time?" and "Whose cost?"

The problem with many of the papers published on this subject involved the fact that the CAI was used as a single intervention rather than as part of an overall behavior modification plan. For example, one study (Ellis, 1981) evaluated CAI at a health fair. Most studies (Consoli, 1995; French, 1983) used CAI as a single intervention focused on knowledge gain or attitude change. There was no mention of how such a system will impact other aspects of a behavior modification program. In this case, the system had a negative impact on the pharmacist who administered the nicotine patch program. This brings up some very interesting questions: "Should CAI remain an isolated intervention?" and "Can CAI be integrated successfully into a full-service smoking cessation program?"

Future directions of this project may be the measurement of six- and twelve-month quit rates. This is the most direct measure of behavior change. However, because of time limitations,

this was not done. Almost all the papers on this subject have focused on knowledge (French, 1983; Consoli, 1995; Skinner, 1993), acceptance, and self-perceived helpfulness (Ellis, 1981).

Future directions (outcomes)

The best indicator of how well the intervention worked would involve measuring six- and 12-month quit rates. This is a true outcome variable; whereas, the ones measured in this study were process and impact variables. Because of time and resource limitations, the outcomes portion of the study was not done. The following may be an approach to a future outcomes study.

Table 6: Summary of Past Studies on Smoking Cessation Interventions

Author	Quit	Attempted to quit	Quit at	Intervention
Zhu,1996				
	5.40%	14.70%	12mo	self-help
	7.50%	19.80%	12mo	quit kit+1 telephone session
	9.90%	26.70%	12mo	quit kit + 6 telephone counseling
Lando, 1990				
	12%		6mo	self-help
	27.00%		6mo	Counseling
Paul, 1996	6%		12 mo	physician advice
	28%		12mo	group courses
Schartz, 1992	17% median of 11 trials. Range 0-33		6 mo	self-help
	5% median 3 trials Range 5 - 12%		6 mo	physician advice
Law, 1995	2%		12 mo	physician advice

The following formula may be used to estimate the sample size of two proportions (percent quit at six and twelve months versus expected quit rate based on literature (Pagano, 1993).

$N=\{[Za*SQRT(P_0(1-P_0))+Zb*SQRT(P_1(1-P_1))]/(P_1-P_0)\}^2$, where

P_0=hypothesized population proportion based on literature
P_1=alternative population proportion
N=sample size
Za=Z value of α error (probability of committing a type 1 error)
Zb=Z value of β error (probability of committing a type 2 error)(Pagano, 1993)

A. ***Null Hypothesis:*** There is no difference in quit rate between intervention group at 6 and 12 months and the expected quit rate based on the literature.

B. ***Subjects:*** Patients waiting in a clinic waiting room

C. ***Sample Size:*** Based on the literature summarized in Table 6, a conservative sample size estimate would be 708+ subjects (P_0=10% and P_1=14%, power=95% using the equation above). A more liberal estimate of the sample would be 55 (P_0=6% and P_1=18%, power=90%). The minimum sample size should be multiplied by 1.5 to account for those who had dropped out or were unable to be contacted.

D. ***Intervention***: The study could use the software as a point of service substitute for clinician advice to quit smoking. Identified smokers could complete the CAI while in waiting room.

E. ***Measurements***: A six- and twelve-month quit rate may be determined using a phone survey or mail. This may produce a bias in social/economic status (SES), since some patients may be homeless or have no phone. Therefore, other contact information must be obtained and used if phone or mail fails to reach the patients. Such a study required all identified smokers to use the program. Allowing patients to self-select may result in a self-selection bias. People who selected a self-help program may be easier quitters and result in better-than-expected quit rates (Mudde, 1996). The additional factor of using a medium such as a computer may select a

more highly intelligent, more motivated, and higher SES group.

*F. **Analysis Plan**:* Direct standardization to adjust for the nuisance factor or logistic regression analysis may account for some of the possible confounders. The population proportions would ideally be derived from the smoking population. After adjusting for confounders or accounting for them in a model, the study proportion of quitters could be compared to the proportion expected from literature, using a Z-test for a proportion (binomial distribution, dichotomous dependent variable, quit/no quit). However, the large sample size required and duration of F/U precluded the study from being done within the three-month period available. The program could be used, however, as a tool for further research by faculty interested in CAI Web-based smoking cessation.

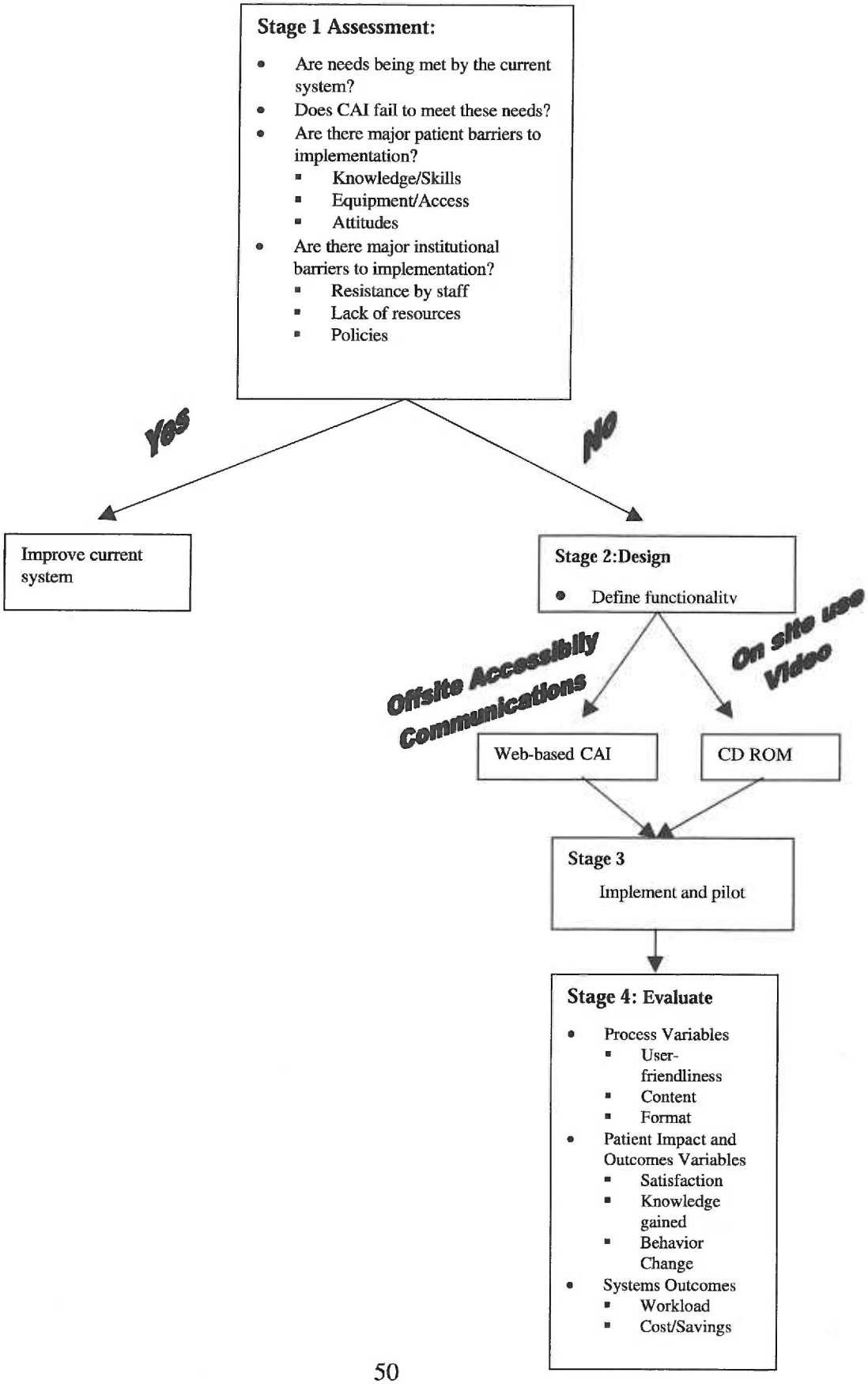
Conclusions

A framework for implementing a CAI for smoking cessation or any other behavior modification program is depicted in Figure 5. Web-based patient education programs show some promise. There was certainly a need for an alternative to traditional patient education classes. However, there were also many barriers to using Web-based patient education. The needs assessment focused on patient-related barriers; as the implementation and evaluation phase progressed, it became apparent that there were also many institutional barriers to taking full advantage of Web-based patient education. For example, security policies restricted the use of Internet mail. Lack of staff interest and time eliminated the possibility of moderated WWW chat group sessions. Because there was only one terminal, patients had to have scheduled computer time. The patient's ability to proceed at his own pace or browse external sites was limited. As a practical matter, projects of this nature should include an assessment of both patient and institutional barriers before implementation.

First, a determination had to be made that there was a need that can be fulfilled by CAI. Next, it must be determined that there are no major institutional and patient barriers to implementation. After that has been determined, implementation and design phases should begin. Functionality should be determined whether CD-ROM technology or WWW technology was chosen. If personal communication and off-site accessibility are valued, then WWW technology should be considered. If a clinic-based system is chosen, then CD-ROM will give better video and audio presentations. Interactivity could be achieved with both formats. The final stage is to assess process, systems, patient impact, and outcomes evaluation. There was a valid concern in this study that this system might increase workload by increasing access. The thought that such a system would reduce workload while increasing access may be unrealistic. Proponents of computer-based

education (Curless, 1987) fail to address the effects of such as an intervention on the system as a whole. The most successful smoking cessation programs incorporate elements of education, behavior modification, counseling, social support, and pharmacological therapy. Although elements such as counseling and support may be done on-line through e-mail and chat rooms, institutional and patient barriers precluded the incorporation of these elements into our program. Some studies (Schneider, 1986) have focused on one element such as on-line smoking cessation. No study thus far has examined the effect of incorporating CAI into a multimodal program. Workload and cost may be shifted as a result of the intervention from one group to another. In this study, workload was shifted from those who taught the class to the PRC staff and the pharmacist. The pharmacist expressed concern that it was better to have one class a month and deal with all the patients in one setting. The CAI intervention spread the patients out over time and disrupted the normal workflow. The question remains whether CAI is best used as an isolated intervention or whether it should be integrated into a complete behavior modification program.

Figure 5: Framework for implementing CAI for smoking cessation



The content and user-friendliness of the program appeared adequate despite a rough start. Greater interactivity could be built in. However, patients may not be able to take advantage of that if they had to rush through it. Web-based patient education systems showed promise, but both institutional and patient barriers needed to be assessed prior to successful implementation. As expected, younger patients were more likely to use the program. While not successful now, the program may offer a solution in the future.

Most of the papers on this subject focused on knowledge (French, 1983; Consoli, 1995; Skinner, 1993), acceptance, and self-perceived helpfulness (Krishna, 1997; Ellis, 1981). Although a knowledge gain was not demonstrated because of small sample size, the question remained as to whether this was an acceptable proxy measure for effectiveness. While knowledge and attitude change may be necessary for behavior change, it did not guarantee it. Many knew about the hazards of smoking, but still smoked. Other factors such as withdrawal symptoms may modulate the effectiveness of educational interventions. Six-month and one-year quit rates would more accurately measured the effectiveness of an intervention. This should be the direction of future studies.

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Appendices

Appendix 1

Date _____

1. Have you ever used a computer: Yes ___ No__

2. Do you own a computer: Yes ___ No__

3. Do you have access now to a computer? Yes ___ No__

4. What type of computer do you own (if applicable):

__IBM/IBM Compatible or clone
__Macintosh
__Other or Don't know

5. What operating system do you use (if applicable):

__DOS
__System 7 series
__Windows series (3.0, 3.1, NT, 95 etc)
__UNIX
__Other or Don't know

6. How do you rate yourself as a computer user (circle one):

Expert Intermediate Beginner

7. How comfortable are you with using a computer (circle one):

Very Comfortable Comfortable Uncomfortable Very uncomfortable

8. Have you ever used a World Wide Web Browser (Netscape, Microsoft Internet Explorer)?
Yes __ No__ Don't know __

9. Do you have access to a modem? Yes __ No__ Don't know __

10. Would you be interested in taking the smoking-cessation classes in computer format?
Yes __ No__

11. How comfortable would you feel in taking the smoking-cessation classes in computer format?

Very Comfortable Comfortable Uncomfortable Very uncomfortable

12. Approximately how far do you have to travel to come to the smoking classes?
_____ miles

13. Is timing of the smoking-cessation classes a problem for you? Yes __ No__

14. How much personal attention do you think you need to quit smoking?

1	2	3	4	5
Very Little				Very Much

15. Under which situation do you work best (Choose one)?
In a group __

By yourself __

16. What is your age? _____ yrs.

17. What is your sex?
male ___ female___

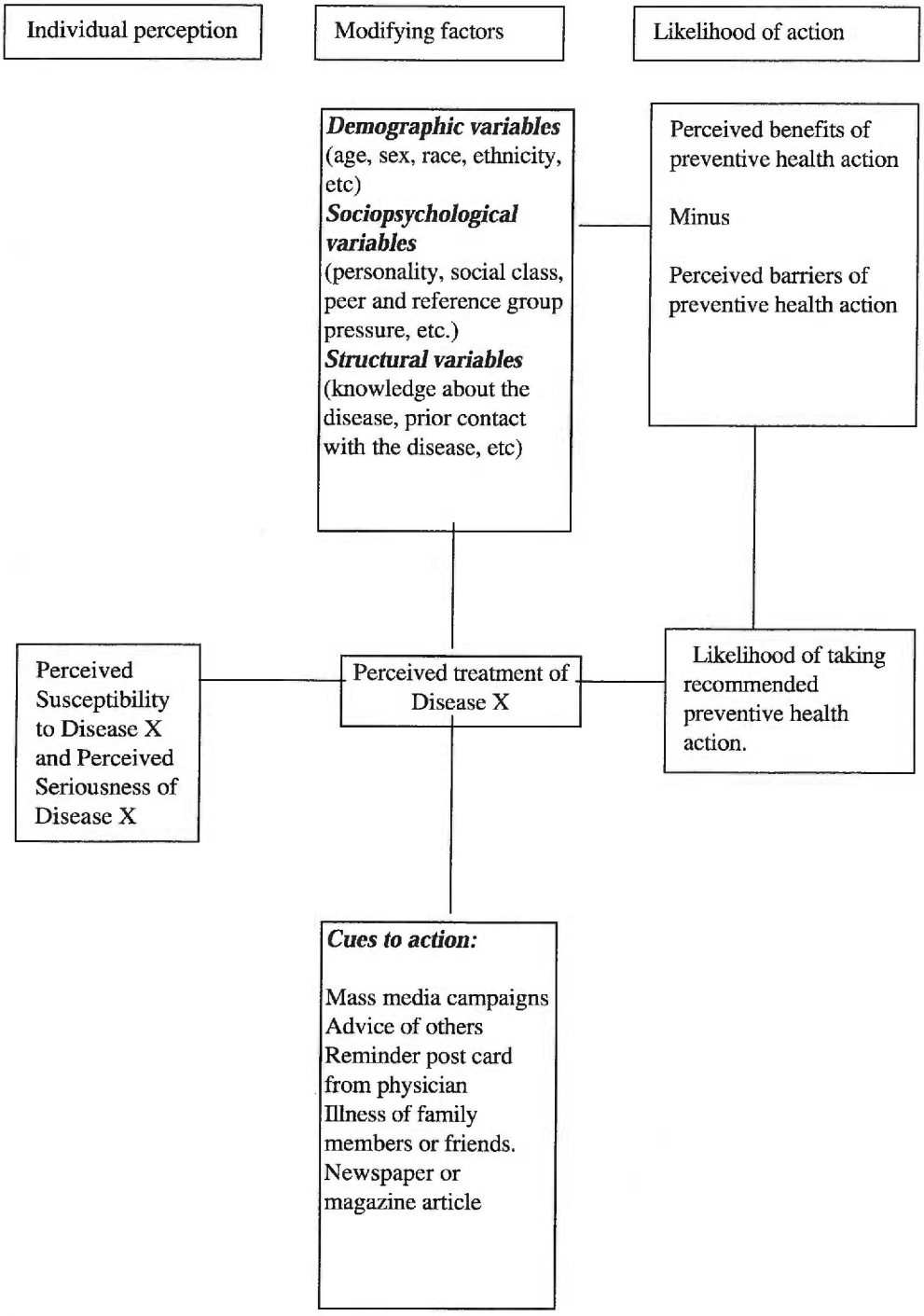
18. What is your race?
White __
Black __
Asian __
Native American __
Other __

19. What is the highest level of education you completed?
Elementary __
Jr. high school __
High school __
Technical __
2-yr. associate __
4-yr. college __
Masters __
Doctorate __

20. What is your Zip Code _____

Appendix 2

Health Belief Model



Appendix 3 COMPLETE PROGRAM SITE MAP

Table of Contents

- Main Home Page
- Introduction
- Stages of Change Questionnaire
  - Branch
    - What is in the cigarette you smoke?
    - Smoking is Harmful to You and Others
    - Health Risk of Smoking
      - Head and Neck
      - Nervous System
      - Pulmonary
      - Cardiovascular
      - Gastrointestinal
      - Urinary Tract/Reproductive
      - Peripheral Vascular Disease
- Your Smoking Contract
- Why I Smoke Questionnaire
- Changing Habits
- Common Triggers
- Stop Smoking Log
- Facts about Smoking
- Anticipating Triggers and Avoiding Them
- What are Your Obstacles to Quitting
- How to Kill an Urge to Smoke
  - Positive Benefits of Quitting
  - Negative Effects of Smoking
- Finding Allies
- Rewards for Quitting
- Relapse Prevention
- What is Stress?
- What is your Stress Level?
- Tips on Stress Reduction
- Relaxation Techniques
  - Picture of a Lake
  - Picture of a Mountain
  - Picture of a Forest
  - Picture of a Ocean
- Dealing with Trouble Sleeping
- Pharmacist and Nursing Intake Form
- Smoking and Weight
  - 4 Food Groups
  - Read Food Labels
- Aerobic Exercise
- Do You Need Nicotine Replacement?
  - Care Provider Consent Form For Zyban
  - Picture Nicoderm
  - Picture Habitrol
- Web Resources For Smoking Cessation

Appendix 4 (Evaluation)

Computer Prior Experience Questions:

1. Have you used a computer before?
Yes ___No ___
2. Are you comfortable using a computer mouse?
Yes ___No ___
3. Are you comfortable using a computer keyboard?
Yes ___No ___
4. Have you used the World Wide Web?
Yes ___No ___
5. Have you used a word processor before?
Yes ___No ___
6. Have you ever written any kind of computer program?
Yes ___No ___

Computer Skills Questions:

7. Were you able to perform the following tasks:

A. Were you able to go to the instruction page?
Yes ___No ___

B. Were you able to get to the Stages of Change Questionnaire and fill it out?
Yes ___No ___

C. Were you able to move to the next page?
Yes ___No ___

D. Were you able to get to the Table of Contents Page?
Yes ___No ___

Go to the **Facts about Smoking** section from the Table of Contents and read the information provided. Stop at the Stop Smoking Contract page.

Use the Following Scale For Questions 8-15:

1=Almost never

2=Some of the time

3=About half the time

4=Most of the time

5=Almost always

Please indicate the extent to which you agree with the following statements:

8. Does the system provide the precise information you need? (circle one)

1	2	3	4	5
Almost never	Some of the time	About half the time	Most of the time	Almost always

9. Does the information content meet your needs? (circle one)

1 2 3 4 5

10. Does the system provide reports that seem to be just about exactly what you need? (circle one)

1 2 3 4 5

11. Does the system provide sufficient information? (circle one)

1 2 3 4 5

12. Do you think the output is presented in a useful format? (circle one)

1 2 3 4 5

13. Is the information clear? (circle one)

1 2 3 4 5

14. Is the system user-friendly? (circle one)

1 2 3 4 5

15. Is the system easy to use? (circle one)

1 2 3 4 5

What did you like best about the program?

_____
_____
_____
_____

What did you like least about the program?

_____
_____
_____
_____

How would you change the program?

_____
_____
_____
_____

Pretest/Posttest Questions (Circle one correct answer for each question)

1. Which of the following is **FALSE** concerning second hand smoke:
___Second-hand smoke increases the chance for middle ear infection in children.
___ Second-hand smoke can worsen asthma in children.
___ Second-hand smoke is associated with 100,000 cases of bronchitis and pneumonia in infants up to 18 months in age.
___Children of parents who smoke are more likely to smoke.

2. Within how many days of quitting will respiratory problems improve?
___1 week
___1 month
___6 months
___1 year

3. Within how many days of quitting, will most (physical) nicotine-withdrawal symptoms disappear?
___1 day
___1 week
___2 weeks
___1 month

4. The risk of head and neck cancer in a smoker is how many times greater than in a non-smoker.
___1 time
___2 times
___4 times
___10 times

5. Which of the following toxins is not a component in cigarette smoke?
___Hydrogen cyanide
___Hydrogen sulfide
___Nitrogen oxide
___Carbon monoxide

6. Smoking increases the risk of which of the following diseases:
___Lung Cancer
___Pancreatic Cancer
___Brain Cancer
___All are correct

7. Smoking is not commonly associated with which of the following:
___Impotence
___Nosebleeds
___Gum disease
___Skin wrinkling

8. Within 1 month of quitting, which of the following is **TRUE**:
___Circulation improves
___Energy and stamina increase
___Pulse rate and blood pressure decrease
___All of the above

9. Smoking increases your risk of lung cancer by how much:
___2 times
___5 times
___10 times
___15 times

10. What percentage of COPD (Chronic Obstructive Pulmonary Disease) and Emphysema deaths are related to smoking:
___60-65%
___70-75%
___80-85%
___90-95%

Flesch Reading Ease Score 77.3
Computes readability based on the average number of syllables per word and the average number of words per sentence. Scores range from 0 (zero) to 100. Standard writing averages approximately 60 to 70. The higher the score, the greater the number of people who can readily understand the document.

Flesch-Kincaid Grade Level 4.5
Computes readability based on the average number of syllables per word and the average number of words per sentence. The score in this case indicates a grade-school level. For example, a score of 8.0 means that an eighth grader would understand the document. Standard writing equates to approximately the seventh-to-eighth-grade level.

Appendix 5

```
<P><FONTCOLOR="#000000"><INPUTTYPE="BUTTON"NAME="Score"
VALUE="Evaluate" onclick="
var a=parseInt(document.nicwithscale.nicwithscale1a.value);
var a1=document.nicwithscale.nicwithscale1a.value;
if (a1==''){
alert ('You forgot to answer question 1');
}
var b=parseInt(document.nicwithscale.nicwithscale2a.value);
var b1=document.nicwithscale.nicwithscale2a.value;
if (b1=='') {
alert ('You forgot to answer question 2');
}
var c=parseInt(document.nicwithscale.nicwithscale3a.value);
var c1=document.nicwithscale.nicwithscale3a.value;
if (c1=='') {
alert ('You forgot to answer question 3');
}
var d=parseInt(document.nicwithscale.nicwithscale4a.value);
var d1=document.nicwithscale.nicwithscale4a.value;
if (d1=='') {
alert ('You forgot to answer question 4');
}
var e=parseInt(document.nicwithscale.nicwithscale5a.value);
var e1=document.nicwithscale.nicwithscale5a.value;
if (e1=='') {
alert ('You forgot to answer question 5');
}
var f=parseInt(document.nicwithscale.nicwithscale6a.value);
var f1=document.nicwithscale.nicwithscale6a.value;
if (f1=='') {
alert ('You forgot to answer question 6');
}
var g=parseInt(document.nicwithscale.nicwithscale7a.value);
var g1=document.nicwithscale.nicwithscale7a.value;
if (g1=='') {
alert ('You forgot to answer question 7');
}
var h=parseInt(document.nicwithscale.nicwithscale8a.value);
var h1=document.nicwithscale.nicwithscale8a.value;
if (h1=='') {
alert ('You forgot to answer question 8');
}
var x=a+b+c+d+e+f+g+h;
```

```
if (x&gt;=7) {
alert ('Your score is ' + x +'.' +' You are likely to experience withdrawal symptoms. Call your
physician to discuss nicotine replacement therapy.');
}
else {
alert ('Your score is ' + x+'.'+ ' You are unlikely to experience withdrawal symptoms');
};
```

Appendix 6

```
#!/bin/Perl
print "Content-type:text/html\n\n";
use CGI(":all");
$soc1=param("soc1");
$soc2=param("soc2");
$soc3=param("soc3");
$soc4=param("soc4");
$soc5=param("soc5");
$soc6=param("soc6");
$soc7=param("soc7");
$soc8=param("soc8");
$soc9=param("soc9");
$soc10=param("soc10");
$soc11=param("soc11");
$soc12=param("soc12");
$soc13=param("soc13");
$soc14=param("soc14");
$soc15=param("soc15");
$soc16=param("soc16");
print("<HTML>\n");
print("<BODY BGCOLOR='FFFFFF'>");
$precontemplation =$soc1 + $soc2 + $soc7 + $soc14;
$contemplation =$soc4 + $soc8 + $soc12 + $soc15;
$action =$soc3 + $soc6 + $soc9 + $soc11;
$maintenance =$soc5 + $soc10 + $soc13 + $soc16;
print("<H1> <FONT COLOR='#FF000'>What Is Your Stage Of Change
\(Highest Score\)</FONT></H1>");
print("<H2>");
for($i=1; $i<=$precontemplation; $i++){
print("<IMG SRC='/~hueyc/d5/BMP/bar.gif' WIDTH=5 HEIGHT=25
ALIGN=left>");
}
print("Precontemplation score is $precontemplation");
print("</H2> \n");
print("<H2>");
for($i=1; $i<=$contemplation; $i++){
print("<IMG SRC='/~hueyc/d5/BMP/bbar.gif' WIDTH=5 HEIGHT=25
ALIGN=left>");
}
print("<P>Contemplation score is $contemplation");
print("</H2> \n");
print("<H2>");
for($i=1; $i<=$action; $i++){
print("<IMG SRC='/~hueyc/d5/BMP/gbar.gif' WIDTH=5 HEIGHT=25
ALIGN=left>");
}
print("<P>Action score is $action");
print("</H2> \n");
print("<H2>");
for($i=1; $i<=$maintenance; $i++){
print("<IMG SRC='/~hueyc/d5/BMP/mbar.gif' WIDTH=5 HEIGHT=25
ALIGN=left>");
```

```
}
print("<P>Maintenance score is $maintenance");
print("<P>");
if ($precontemplation>$contemplation && $precontemplation>$action){
        if($precontemplation>$maintenance){
        print("Your stage is precontemplation");
        $link=1;
        }
}
elsif ($maintenance>$precontemplation && $maintenance>$action){
        if ($maintenance>$contemplation){
        print("Your stage is maintenance");
        $link=2;
        }
}
elsif ($contemplation>$action && $contemplation>$maintenance){
        if($contemplation>$precontemplation){
        print("Your stage is contemplation");
        $link=3;
        }
}
elsif ($action>$contemplation && $action>$precontemplation){
        if($action>$maintenance){
        print("Your stage is action");
        $link=4;
        }
}

if ($link==1 || $link==3){
print("<P><A HREF='/~hueyc/d5/poison.htm'>Next</A></P>");
}
elsif ($link==2 || $link==4){
print("<P><A HREF='/~hueyc/d5/contract.htm'>Next</A></P>");
}
else {
print("<P>You do not have a predominate high score for a stage.");
print("<P>Write down stages with highest score</P>");
print("<P><A HREF='/~hueyc/d5/poison.htm'>Next</A></P>");
}
print("<P><A HREF='/~hueyc/d5/SOC.htm'>Back</A></P>");
print("</H2> \n");
print("</BODY>\n");
print("</HTML>\n");
```