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Interactive Mobile System for Smoking Cessation

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Abstract— **Tobacco use remains the single largest preventable cause of death and disease in the United States. We developed an interactive mobile system to facilitate smoking cessation by identifying which stage of change the patient was currently in and creating a custom intervention and cessation action plan based upon their feedback and experience. It is designed to follow the patient through their smoking cessation experience and adapt to their changing attitudes over time. We piloted this program with 49 current smokers hospitalized at Johns Hopkins Hospital. The mobile smoking cessation system was generally well received by hospitalized patients. Improvement in attitudes and stage of change were noticed between pretest and posttest, suggesting an ability to help change patient's attitudes towards smoking and motivate them to quit. Providing real time decision support and tailoring the content shown to the patients to their personal profile can be a viable means in smoking cessation.**

I. Introduction

Tobacco use remains the single largest preventable cause of death and disease in the United States. Approximately 443,000 U.S. adults die from smoking-related illnesses each year [1]. Smokers lose at least one decade of life expectancy, as compared with those who have never smoked. Cessation before the age of 40 years reduces the risk of death associated with continued smoking by about 90% [2].

Smoking cessation education can increase intervention rates [3]. Electronic platforms have shown promise in aiding smoking cessation education and increasing quit rates [4].

According to the Transtheoretical Model, the process of smoking cessation can be broken into 5 stages [5]:

1. **Pre-contemplation** – Patient does not see the value of quitting
2. **Contemplation** – Patient sees the value of quitting but is not ready now
3. **Preparation** – Patient is ready to quit
4. **Action** – Patient is quitting now
5. **Maintenance** – Patient has quit for at least 6 months

Each stage of smoking cessation has different requirements and challenges for moving forward and each patient has a different attitude and knowledge background making a customized intervention preferable to a one size fits all approach.

We aimed at designing an interactive mobile system to facilitate smoking cessation by identifying which stage of change the patient was currently in and creating a custom intervention and cessation action plan based upon their feedback and experience. It is designed to follow the patient through their smoking cessation experience and adapt to their changing attitudes over time. Hospital stay is a teachable moment in each patient life during which they may be more susceptible to health counseling. We piloted this program with 49 current smokers at Johns Hopkins Hospital.

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II. Methods

A. The LAST System

The Transtheoretical Model [5] describing stages of change towards accepting certain lifestyle behaviors has been used in development of an interactive mobile system entitled Lifestyle Automated Support Technology (LAST). The LAST system has been designed to counsel individuals in an individualized way tailored to their current stage of change. The LAST system for smoking cessation (Smoking LAST) uses a touch screen tablet to display the LAST program. The program asks the user a series of questions about their smoking and their attitudes towards smoking to determine in which stage of cessation the patient is currently in. The program designs a custom intervention plan in real time for the patient depending on their answers and accommodates their personal background as they move through the stages of smoking cessation.

The program was developed in Visual Basic.NET for Windows operating systems and designed to be used with touch screen tablet PC computers. It is designed to be as simple as possible to be usable by people with little to no computer experience and of any educational background.

Figure 1. Smoking LAST question screen

The program begins by determining which stage of smoking cessation the patient is in as seen in Fig. 1. Once

the stage is determined, challenges to quitting are identified and addressed.

For patients in the pre-contemplation stage, the program first determines whether they are unaware of the health risks of smoking, in denial about smoking risks and believe they do not apply to them, or believe smoking is worth the risk to their health. For risk unaware patients an educational curriculum on the hazards of smoking is administered as seen in Fig. 2. Computer-assisted education on hazards of smoking in current smokers has been previously described [7]. It was shown to significantly increase smokers understanding of health risks associated with smoking. For patients in risk denial an attempt is made to personalize the risk to the patient. If this is not successful the patient is given inspirational testimonials. For patients who know the risks but believe smoking is worth the risk an effort is made to assess and change their decision balance (how they view the pros and cons of smoking in regard to quitting).

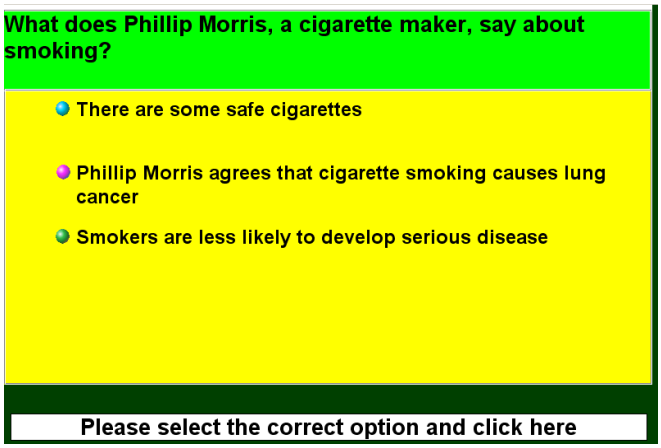

Figure 2. Smoking LAST educational question screen

Patients determined to be in the contemplation stage are questioned about their barriers to quitting and they are reviewed with the patient as shown in Fig. 3. If the patient indicates that all barriers are resolved they move on to the preparation stage the next time the program is completed, otherwise barriers are reviewed and strategies for resolving them are suggested by the program.

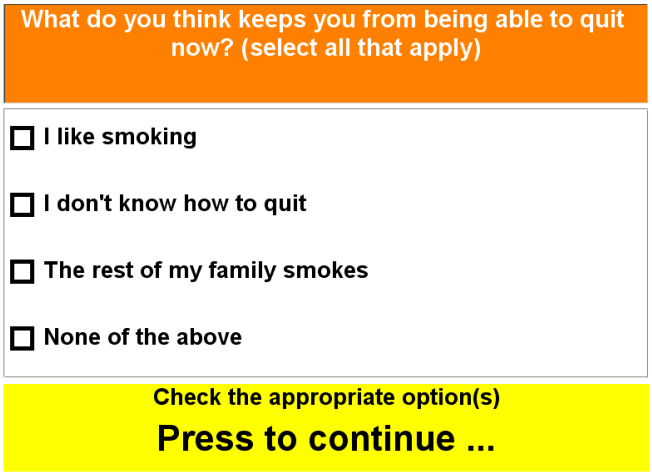

Figure 3. Barriers screen

Patients in the preparation stage answer a series of questions about use of cessation medications as seen in Fig. 4, review the risks and benefits of smoking, then either review reasons to quit or generate a list of smoking triggers and determine coping strategies for the triggers. Once this is completed an action plan for quitting is generated and reviewed with the patient including the quit date.

Figure 4. Smoking cessation medications screen

Patients in the action and maintenance stage of smoking are asked if they have smoked in the past 24 hours. If they have, the program tries to assist in recovery by reviewing their action plan, identifying the cause of the slip up, reviewing medications, and asking about coping strategies. If the patient has not smoked, they enter the maintenance stage where their risk of slipping up is evaluated, side effects are monitored, and their action plan is reviewed if necessary.

The algorithms used for each preparation stage in the Smoking LAST program are shown in Fig. 5-9.

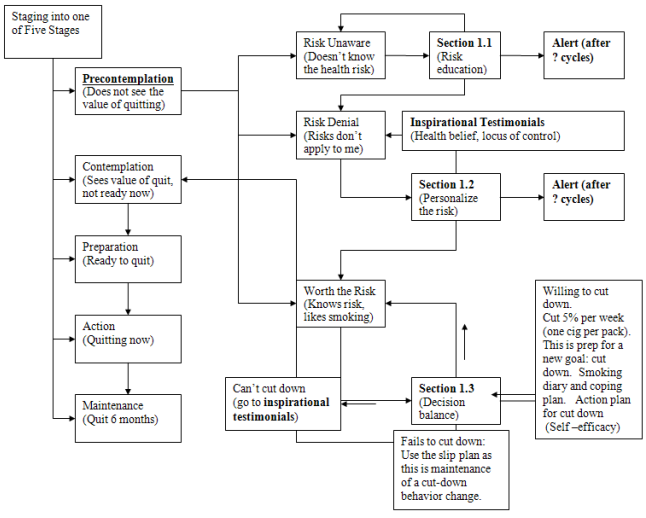

Figure 5. Pre-contemplation workflow

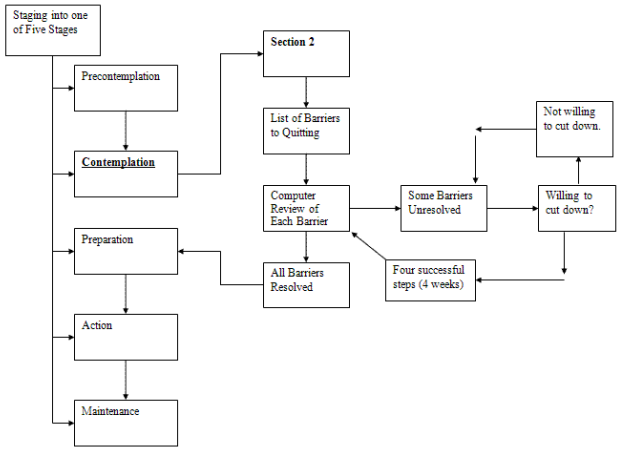

Figure 6. Contemplation workflow

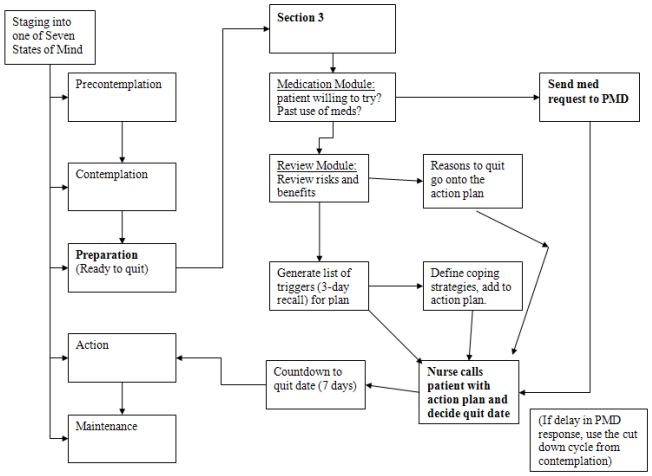

Figure 7. Preparation workflow

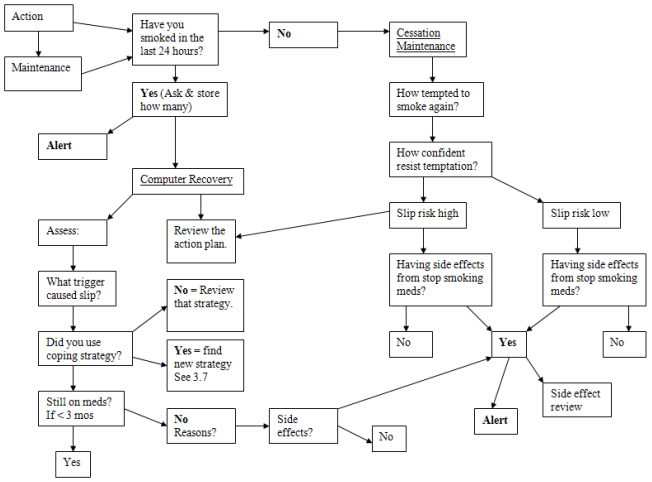

Figure 8. Action/Maintenance workflow

B. *Study Design*

We tested the system with 49 hospital patients who were also smokers. Patients were first asked to fill in the pre-test forms which included socio-demographics, smoking history, Fagerstrom scale, attitudes toward smoking, smoking stage of change, smoking processes of change, smoking self-efficacy / temptation, smoking decisional balance, and hazards of smoking knowledge questionnaire.

The patient then went through the Smoking LAST program by themselves on a tablet computer. Since the main goal of this pilot study was assessment of acceptance by hospitalized patients of in-hospital computer-mediated smoking cessation counseling, the patients were given the tablet only for 6-8 hours. The pre-test data usually were collected in the morning, and the post-test data – in the late afternoon of the same day. After completing a trial session, the patient filled in the post-test forms which included smoking behavior questionnaires collected at baseline and an attitudinal survey which was administered to get patient feedback on the system feasibility acceptance.

III. RESULTS

Overall, 49 consecutive current smokers hospitalized at Johns Hopkins Hospital were enrolled into the study. Patient age ranged from 19-80 years old with the mean age being 48.3±13.5. Patient results from the Fagerstrom test for nicotine dependence are shown in Table I. A score of 5 or more indicates a significant dependence, while a score of 4 or less shows a low to moderate dependence.

Table I. Fagerstrom Scale

Total	Frequency	Percent
<5	13	26.5
>=5	36	73.5
Total	49	100.0

In the attitudinal survey 91.9% (45) of respondents said that using the Smoking LAST tablet was "Not complicated at all" while 4.1% (2) found it "Slightly complicated" and 2% (1) each found it "Moderately complicated" or "Very complicated." Patient response was also highly positive when asked about difficulty moving from one screen to another, difficulty reading text from the computer screen, size of the text, colors used, audio/visual content, new information received, and understanding educational content.

Table II. Decisional balance pre-test

Pretest	Questions	Mean	SD	Min	Max	N
Pros	1, 3, 5, 7, 9, 11, 13, 15, 17, 19 Max – Min: 50 – 10	27.8	8.8	12.0	47.0	49
Cons	2, 4, 6, 8, 10, 12, 14, 16, 18, 20 Max – Min: 50 - 10	31.3	8.1	15.0	47.0	49

Table III. Decisional balance post-test

Posttest	Questions	Mean	SD	Min	Max	T test Pre-post
Pros	1, 3, 5, 7, 9, 11, 13, 15, 17, 19 Max – Min: 50 - 10	26.5	8.0	15.0	45.0	0.45
Cons	2, 4, 6, 8, 10, 12, 14, 16, 18, 20 Max – Min: 50 - 10	31.7	7.8	13.0	50.0	0.85

The Decisional Balance Scale assesses the salience of the patterns of use compared with the motivations for quitting. This comparison provides a measure of an individual's status regarding their decision to continue or discontinue

cigarette smoking [6]. The Pros scale contains items representing the pleasure, tension reduction, self-image, and habit factors identified as the basic reasons for cigarette use. The Cons scale items, on the other hand, represent the health, example, aesthetics, and mastery considerations associated with motives for quitting. A slight increase in the cons of smoking identified by the patients was shown as well as a decrease in the pros identified as shown in Tables II and III.

In the pre-test Smoking Stage of Change survey 40.8% (20) of respondents were in the preparation stage, 38.8% (19) were in the contemplation stage, while 20.4% (10) were in the pre-contemplation stage. After completing the Smoking LAST trial 44.9% (22) of respondents were in the preparation stage, 38.8% (19) were in the contemplation stage, while 16.3% (8) were in the pre-contemplation stage. As illustrated in Fig. 8, there was a significant shift in the distribution of patient readiness to quit smoking with decrease of smokers who even didn't consider quitting (pre-contemplation) and increase of smokers who were ready to set a definite quit date (preparation). Overall, 8% of the study subjects had their stage of change moved to more favorable direction. This is a very promising result given high level of nicotine dependence in the study group and the fact that they used the system only for several hours.

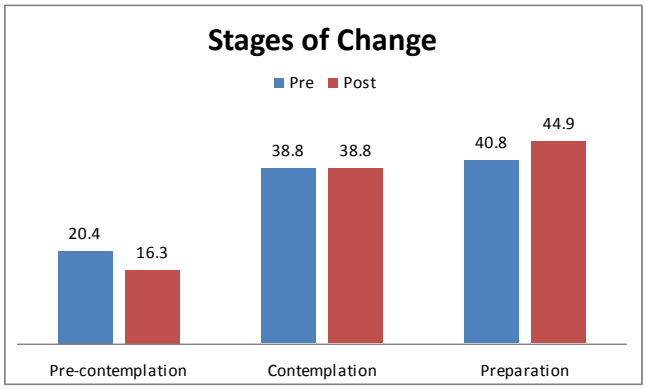

Figure 9. Stage of change before and after using Smoking LAST

IV. Discussion

In this pilot study, we assessed potential feasibility of using interactive mobile device for smoking cessation counseling in hospitalized patients. Our results demonstrated that even after a short exposure to the intervention tailored to the patient individualized profile significant changes occurred in patient level of readiness to quit smoking. These results certainly encourage further investigation with longer follow-up outside hospital setting.

Our results are supported by previous reports which demonstrated potential of interactive education about hazards of smoking [7-8]. Previous studies also showed high acceptance of mobile devices for interactive health education [9-11]. Interactive tailored health education was shown to be more effective than reading brochures [12-13] or browsing internet [14]. The proposed model of interactive patient counseling can be extended to multiple health behaviors [15-16].

V. Conclusion

The Smoking LAST system was generally well received by hospitalized patients and its use resulted in improvement of smoker readiness to quit smoking. To fully test the proposed system, the smokers will have to use it for a prolonged period of time outside hospital. Providing real time decision support and tailoring the content shown to the patients to their personal profile can be a viable means in smoking cessation. We believe it could be a valuable tool for aiding smoking cessation and a larger study is warranted.

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