

Web-based Tailoring and its Effect on Self-Efficacy: Results from The MI-HEART Randomized Controlled Trial

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This paper reports the effects of a tailored Web-based delivery system on self-efficacy as it relates to a patients' response to acute myocardial infarction (AMI) symptoms. The data reported are from MI-HEART, a randomized trial examining ways in which a clinical information system can favorably influence the appropriateness and rapidity of decision-making in patients suffering from symptoms of acute myocardial infarction. Participants were randomized into one of three groups: tailored Web-based, non-tailored Web-based and non-tailored paper based. A theoretically based behavioral-cognitive model was used to identify key variables upon which to tailor education material. One key variable in the model is self-efficacy, defined as an individual's confidence in his or her ability to take action to perform the behaviors necessary. In this study, self-efficacy was operationalized with a three-dimensional scaling. Results show trends in improved self-efficacy scores for all groups at 1-month follow up, with sustained significant increases in baseline to 3-month scores only in the tailored Web-based group. One possible explanation could be related to "hit-count", which was significantly higher in the tailored group. This study is a first step in quantifying the contribution of Web-based tailoring over non-tailoring in changing key determinants of patient delay in response to AMI symptoms.

INTRODUCTION

The need to develop an Acute Myocardial Infarction (AMI) Symptom Response Self-Efficacy Scale became apparent in the course of the MI-HEART Project. This project, funded by the National Library of Medicine, examines ways in which a clinical information system can favorably influence the appropriateness and rapidity of decision-making in patients suffering from symptoms of acute myocardial infarction. Our hypothesis is that educational strategies tailored to information from a patient's medical record will exert a favorable influence on measurable parameters of the patient's cognitive process, suggesting that they are more likely to perform appropriately in an acute situation.

The data-driven and highly individualized messages generated by tailoring provide specific information

matched to the characteristics of an individual. The process for generating Web-based tailored messages involves the following. People are surveyed with a baseline questionnaire and the survey results are stored in a data file. Computer software is written that links the data with a feedback source containing appropriate feedback for each survey response. The software consists of algorithms to select the feedback segments and assemble them into a predetermined format for Web delivery. Content expertise is needed both to determine the correct feedback information and to formulate the decision rules on which the computer program is based. The computer program then generates output for each individual, based on his or her personal survey results.

The availability of powerful computers makes it possible to use almost infinite survey results and feedback sources with numerous variations in specific feedback messages for computer tailoring. Nevertheless, the characteristics to which the information is tailored should be relevant and important for the behavior change that is targeted with the tailored intervention. An important criterion for limiting the list of tailoring variables is to apply theoretical insights about determinants of the behavior and processes of behavior change.

In the MI-HEART project, we developed a theoretically based behavioral-cognitive model for patient decision making to identify key variables upon which to tailor educational material.¹ Our model includes somatic and emotional awareness, perceived threat (vulnerability and susceptibility), expectations of symptoms, self-efficacy and response efficacy to explain the response of an individual to their symptoms. The focus of our research was to empirically investigate if a tailored Web-based delivery system could influence measurable parameters of the patient's cognitive process-attitudes and beliefs, suggesting that they are more likely to perform appropriately in responding to AMI symptoms.

This paper reports on a key construct contained in our model: self-efficacy. We compared computer tailored messages designed to influence self-efficacy to non-

tailored Web- and paper- based messages. Our goal was to assess the influence of the Web-based tailored messages on self-efficacy, positing that the Web-based tailored messages combines the attributes that can most favorably influence self-efficacy scores.

AMI SYMPTOM RESPONSE AND SELF-EFFICACY THEORY

Self-efficacy beliefs reflect people's thoughts about their capability to perform certain behaviors.² To develop the self-efficacy scale, we utilized theory and empirical data published by Bandura concerning the role of self-efficacy in behaviors which closely resemble the behavior of patient response to AMI symptoms.^{3,4,5} Comparable to other behavioral responses to fear-provoking stimuli, AMI symptoms create high levels of anxiety arousal, the need for a coping strategy, and the need for cognitive control of intrusive negative thinking in a threatening situation.

To illustrate how self-efficacy plays an important part at each of these levels, consider the following: When a patient experiences and attends to symptoms, whether attributed to a cardiac origin or not, individual homeostasis is typically upset and affects the physical and psychological well being of the person. This state of disruption requires action on the part of the individual to restore balance or equilibrium. To restore equilibrium, an individual will appraise the stressor and the psychological and social responses at his or her disposal. This process requires that the individual evaluate the potential threat as well as his or her ability to alter the situation and manage negative emotional reactions. Efforts aimed at problem management and emotional regulation give rise to the coping process.

The coping process consists of primary and secondary appraisals. In the primary appraisal, an individual must use judgment about the significance of the symptoms, and assign a cause in order to define the appropriate action. Appropriate action is largely a decision made by the patient as he or she undergoes the process of identifying the cause of symptom sensations. Appropriate action is defined by causal origin assigned to the symptom sensations experienced. *Self-efficacy at this dimension measures the individual confidence to label the symptoms experienced.*

During secondary appraisal, self-efficacy influences the individuals' assessment of their coping resources and options, and pertains to beliefs about their ability to perform the behaviors necessary to exert control of

symptoms. At this dimension, *self-efficacy pertains to the individuals' confidence that these actions can be performed.*

At a third dimension, self-efficacy affects how a person manages negative emotions in response to a perceived threat. According to Bandura, threat is not a fixed property of situational events. Rather, threat is a relational property concerning the match between perceived coping capabilities and potentially hurtful aspects. A low sense of efficacy to control negative thinking generates self-debilitating thought patterns that give rise to anxiety and avoidant behavior. Accordingly, people with high cognitive self-efficacy will experience less anxiety when responding to AMI symptoms and will also be less likely to manifest disengaging coping strategies, such as avoidance and denial, which are responses often suggested to explain a patient's delay in responding to AMI symptoms. Conversely, individuals with low cognitive self-efficacy will experience impaired functioning levels and may not respond with appropriate action even with knowledge regarding what actions should be performed. Low levels of self-efficacy in coping with the potential threat of an AMI will lead individuals to approach the situation anxiously, and the experience of disruptive arousal in turn lowers their sense of efficacy that they will be able to perform the necessary actions. *This dimension of self-efficacy beliefs affects the self-regulation of cognitive processes.*

Operationalizing the measurement of self-efficacy with three-dimensional scaling represents a novel approach to understanding patient response to AMI symptoms. To date, there are no studies that have reported efforts to dimensionally operationalize this measure or empirically test its effect on patient delay in response to AMI symptoms. In this present study, we are mainly concerned with findings to empirically investigate the computer tailoring technique in changing self-efficacy beliefs. This present paper reports the methods, results and implications of the first empirical evaluation of a tailored web-based delivery system designed to affect a key determinant of patient response to AMI symptoms.

METHODS

Participants

Participants were recruited from physicians' offices, advertisements, online resources, and promotional materials e.g., brochures and flyers. Potential participants interested in the study were sent a letter

asking them to provide consent, and consent from their physician. Physicians were also asked to confirm eligibility according to predetermined AMI risk criteria.

Study Design and Procedure

A three-group randomized controlled design with pre- and post intervention measures was used to determine the effectiveness of tailored messages in changing AMI self-efficacy. Following consent, all participants completed an online baseline questionnaire and were then randomized into one of three groups: (1) tailored Web-based, (2) non-tailored Web-based and, (3) non-tailored paper based. After completing the questionnaire, participants in the Web-based intervention groups had access to the educational materials online. The paper-based intervention received the educational materials by mail.

The Tailored Web-based Intervention

Algorithms were prepared by investigators to determine which set of baseline responses triggered selection of which tailored messages. Content of the messages were hand-authored, based on self-efficacy change theory. For example, the “self-efficacy pages” for those rating low contained pictures, encouraging text, and audio testimonials modeling the behaviors of others who were successful in accomplishing the tasks of seeking help in responding to AMI symptoms specific to each dimension of self-efficacy scale.

Non-Tailored Interventions

Both non-tailored groups also received messages based on variables in the model, but these messages were not tailored to their baseline measures.

Measurement

The baseline questionnaire contained items to measure the cognitive variables as described in the theoretically based model on patient delay to AMI symptoms. Other variables of interest including rating of present health, past and present health conditions, and health care utilization. We also assessed intention to respond to AMI symptoms under a number of different scenarios, totaling 51 items and three subscales. The items in the AMI Symptom Response Self-Efficacy scale measured each of the dimensions described in the previous section: self-efficacy to label symptom sensations (SE:Symptoms), self-efficacy to respond to symptom sensations (SE:Action), and cognitive control self-efficacy (SE:Cognitive). Within each dimension, items portrayed different levels of task demands, and

represented personal abilities to produce specified levels of performance. Participants were asked to rate the strength of their belief in their ability to execute the requisite activities. The strength of their belief was recorded on a scale ranging in 10-unit intervals. Each dimension yielded an efficacy score summed and divided by the total number of items to indicate the strength of perceived self-efficacy for the activity domain.

Statistical Analysis

The study outcome on which we focus here are changes in self-efficacy scores. Repeated measures of analysis of variance (ANOVA) were conducted to assess between group differences over time in self-efficacy scores. Secondly, pair-wise comparisons were undertaken using an alpha level adjusted for multiple comparisons.

RESULTS

Study Population

Of the participants who enrolled in the study (N=94), most were male (71%), married (77%), Caucasian (89%), with college or professional/postgraduate degrees (68%). Mean age was 57 years (SD=10 years), 20% had yearly incomes between 50,000 and \$74,000, and 35% had yearly incomes over \$75,000.

Changes in Self-Efficacy Scores

Table 1 presents self-efficacy scores for baseline and follow up across the three experimental conditions and overall. Analysis of variance was performed on baseline measures to determine if randomization to intervention groups was effective. This analysis showed no differences among the groups at baseline. Changes in self-efficacy scores were compared using repeated measures of analysis of variance with Time and Study Group as the within subject and between-subject factors. For SE:Symptoms, changes across follow-ups were significant ($F=3.3, p<.05$). The interaction between time and experimental condition was also significant ($F=2.3, p<.05$). Between group significance was also found in SE:Action ($F=.237, p<.05$), and SE:Cognitive ($F=2.59, p<.05$). Within group differences were not significant for SE:Action and SE:Cognitive.

Baseline to 3-Month Follow Up

Continued analysis removed the 1-month follow-up measure and included only difference in baseline to

Table 1: Self-Efficacy Scores for Baseline and Follow-up across Experimental Condition

	Baseline Mean (N)	1-Month Follow-up Mean (N)	3-Month Follow-up Mean (N)
Tailored			
Symptoms	5.59 (31)	6.61 (21)	7.99 ^{b**} (17)
Action	6.24	7.59 ^{a*}	8.35 ^{b*}
Cognitive	5.98	7.14 ^{a*}	8.02 ^{b**}
Non-Tailored			
Symptoms	5.34 (31)	6.48 (22)	5.59 (13)
Action	7.21	7.65	6.65
Cognitive	6.71	7.04	6.27
Paper-Based			
Symptoms	6.00 (32)	7.48 ^{a*} (20)	6.00 (17)
Action	6.78	8.73 ^{a*}	6.78
Cognitive	7.49	7.53	6.35
Total			
Symptoms	5.65 (94)	6.84 ^{a*} (63)	6.61 ^{b*} (47)
Action	6.74	7.95 ^{a*}	7.31 ^{b*}
Cognitive	6.44	7.22 ^{a*}	6.93 ^{b*}

NOTE: Analysis performed using repeated-measures analysis of variance.

a. Significant difference baseline versus 1-month follow-up.

b. Significant difference baseline versus 3-month follow-up.

*p < .05. **p < .001

3-month follow-up measures. For the tailored group, there were significant mean increases in baseline to 3-month measures for SE:Symptoms ($p < .005$), SE:Action ($p < .05$), and SE:Cognitive ($p < .005$). Differences in mean increases from baseline to 3-month follow up did not reach significance in both non-tailored web- and paper-based groups.

Analysis of "Hit-Count"

The Web-based delivery of our intervention allowed us to look at the usage logs to determine if there were differences between tailored and non-tailored groups with respect to the frequency of system use. Usage was determined by "hit-count", the number of times the user selected a specific Web page to view. Note that the user could have performed many actions on one specific Web page e.g., print the contents of the page, scroll, and select audio clip. In this analysis, each repeated action on a given Web page counts as one hit. The mean "hit-count" in the tailored groups was significantly higher than the non-tailored group, 21.8 and 12.4 respectively ($t = 2.09$, $p < .005$).

DISCUSSION

The results of our randomized controlled study show trends in improved self-efficacy scores for all groups at 1-month follow-up, with sustained significant increases in scores only for the Web-based tailored intervention in all dimensions; labeling symptoms (SE:Symptoms); taking action (SE:Action), and cognitive control (SE:Cognitive). According to our hypothesis, we anticipated that the tailored intervention would more favorably influence self-efficacy scores; however, new questions arise as to why the tailored intervention was the only group to sustain the effect at 3-months.

One possible explanation could be related to exposure. The logs on "hit-count" show that use of the tailored intervention was significantly greater when compared to the non-tailored web group. Of course, we have little to say about the paper-based group since these data were not logged.

Previous studies have already alluded to reasons why tailored interventions are more effective than non-tailored or generic type information.^{6, 7, 8} Since tailoring provides each person only the information selected for his or her characteristics, the messages contain less redundant information. People are

therefore more likely to pay attention to the essential relevant information. Attention to the message is essential for the health message to have an impact.⁹ Few previous studies were able to assess usage as we have done in this study, because most have used a paper based delivery system. Based on the data we report here, exposure as defined as "hit-counts" may shed light on why tailored interventions have a greater impact. Tailored interventions may not only increase attention, but also increase the cognitive effort that people are willing to invest in reading, comprehending and processing a message.

There are some limitations to this study that should be taken into consideration in interpreting the results. Characteristics of study participants in this Web-delivery system reached a select population that was Caucasian, highly educated, and predominately male, despite our efforts to recruit a more diverse population. Further investigation is needed to determine why this occurred and what changes could be made to the intervention, or the recruitment methods employed. These issues are important, since merely making a promising program available via the Web does not seem to result in the use of the program by a diverse target audience.

Attrition also appears to be a limitation. However, recruitment for MI-HEART is still ongoing, and a number of participants are still in the process of completing follow up questionnaires.

CONCLUSION

A limited number of studies have used theoretical insights from behavior change theory to develop a model of a patient's response to AMI symptoms.^{10, 11} To our knowledge, we are the first to employ a Web-based delivery system to positively influence the pre-behavioral determinants a model of patients response to AMI symptoms in a randomized trial. The focus of this paper is on self-efficacy, one key construct contained in our model. We have shown in this analysis that a tailored Web-based intervention can favorably impact self-efficacy. Further analysis of data collected in the MI-HEART project will examine other constructs contained in the model, their interaction with contextual variables, and their impact on intention to perform under various scenarios (symptom sets), which is defined as the dependent variable in this project.

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