TLC: An Informatics Approach to Enable Patients to Initiate Tailored Lifestyle Conversations with Providers at the Point of Care

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Abstract

Chronic illness including cardiovascular disease (CVD) is a major burden on the healthcare system. Behavioral and lifestyle changes could significantly reduce the burden of CVD, but provider counseling for behavior change is a very challenging, and often ineffective task. We have developed a patient-centric decision support tool to be incorporated into an Electronic Health Record system (EHR). The tool provides tailored feedback on behavioral risk, readiness and confidence in an effort to empower patients to make decisions about improving health behaviors. In turn, the tool will facilitate an informed and balanced discussion between patients and their providers about behavioral changes, incorporating both the clinical view and the individual's preferences for choosing among multiple behavior change goals based on their psychosocial characteristics, and evaluation of benefits and barriers.

Keywords: Health behavior, health promotion, computer-based tailoring, decision support

Introduction

Although chronic diseases are among the most prevalent and costly health problems, they are also among the most preventable[i]. It is well understood that lifestyle and health behaviors such as tobacco smoking, sedentary habits, and poor nutrition have a critical role in contributing to heart disease and other chronic conditions. Given the close association between risky health behaviors and chronic disease, particularly heart diseases, Therapeutic Lifestyle Counseling (TLC) is recommended in several clinical preventive guidelines (CPG). It is an evidence-based approach to improving cardiovascular health by linking changes in diet, physical activity, weight loss, and behavior to promote a healthier lifestyle[ii]. The National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III guidelines emphasize TLC for persons at risk for CVD[iii].

Despite evidence to suggest that TLC can be effective it has had limited uptake because of the barriers physicians face in implementing the guidelines. Providers receive little training in behavioral theories and determinants of health or on behavioral counseling techniques[iv]. Behavioral counseling must be patient-centric, grounded in behavioral theory, and personally relevant and specific in order to be effective[v]. With the average patient encounter lasting 15 minutes or less, providers have little time to conduct psychosocial assessments or provide focused behavioral counseling[vi]. Current clinical systems, such as EHRs, lack the facility to assess the behavioral and psychosocial parameters of patients and to provide decision support to providers to engage their patients in lifestyle discussions.

Background

Behavioral counseling can be made more effective by tailoring recommendations to an individual instead of using generic recommendations like "eat healthier" or "get more exercise"[v]. Tailoring involves administering a personal assessment and then generating feedback that is based on the individuals' attributes. The theoretical basis for tailoring is tied to the Elaboration Likelihood Model (ELM) that explains the cognitive processing of information targeted to individuals[vii]. ELM posits that people are more likely to attend to and actively process information if they perceive it to be highly and personally relevant, making tailored information significantly more effective than generic, "one-size-fits-all" information. A recent meta-analysis found that tailoring health communications had a greater impact on health behaviors than did comparison/control conditions, with some of the most successful interventions being those that addressed smoking, physical activity or diet[viii].

Computers are particularly well suited, and have been found to be effective for generating tailored output based on a set of rules to process user input [ix]. While the literature on using cognitive behavior and psychosocial data elements for tailoring health behavior change interventions are numerous, we found few projects that incorporate this aspect into clinical systems or workflow, let alone EHRs that make use of an evidence-based CPG and its inherent decision logic for behavior change counseling. Davis and Abidi report on the preliminary design and development of PULSE, a web-based system to generate tailored patient education in a primary care setting[x]. The system uses clinical guidelines to assess the risk for CVD, and also incorporates stage of change from the Trans-theoretical Mode (TTM)[xi]. Personalization algorithms are then used to select relevant messages to compose the educational material for an individual patient based on their level of readiness for change. Similarly, Jones et al., describe a Guideline Execution Model approach to generate tailored patient education materials by modifying an evidence-based CPG for managing dyslipidemia[xii].

These systems described above extend tailoring into the clinical setting, but have certain limitations. One, the tools are simply static educational materials and don't provide a basis for a patient-provider discussion. Two, the systems require a health professional to complete the health assessment and do not directly empower the patient to take initiative, nor do they involve the patient in decisions about behavior change. Third, they are not integrated with EHRs or Personal Health Records (PHRs), which significantly reduces their uptake in the clinical workflow.

Tailored Lifestyle Conversations (TLC)

In this paper we describe our efforts to develop a computer-based tailoring system that draws from the prior literature but also incorporates innovative new aspects. TLC is based on the NCEP Cholesterol guidelines and draws from theoretical constructs in behavior theory to tailor content to the individual's psychosocial characteristics and health behavior determinants. The system includes a health assessment and a tailored output that guides patients in making decisions about behavior change based on their individual level of risk, readiness and confidence. Hence we have named our system the Tailored Lifestyle Conversation (TLC) system because it assesses, advises and enables a conversation (as different from counseling) between the patient and provider and incorporates both the clinical and the individual points of view.

Methods

Building a tailoring system requires several key steps including a) development of the tailoring assessments, b) creating and coding the decision algorithms, c) composing the tailored messages, d) designing the feedback output, e) implementation and f) evaluation[v]. We describe steps a-e in this section and step f as part of ongoing work in the discussion section.

Development of the Assessments

In developing the assessment, the NCEP guidelines were used as starting point to create a list of data elements. An advisory committee representing experts from different healthcare backgrounds was used in a modified Delphi method to narrow down the assembled list of data elements and arrive at a final list of 30 elements[xiii]. The assessment questions, derived from validated instruments, assess status, self-efficacy, and readiness to change for four behavioral risk factors for CVD: weight management[xiv], physical activity[xv], dietary habits[xvi], and tobacco smoking[xvii]. Self-efficacy measures the individual's level of confidence to make the behavior change. Readiness to change (or Stage of Change) is described by the TTM as the process of behavior change, which takes place over time, and ranges from precontemplation to action and maintenance. All assessment questions were selected with consideration of quality and feasibility characteristics, such as validation, suitability to purpose, comprehensibility for patients, length, and adequate scoring algorithm.

Developing the Tailoring Algorithm

The tailoring component of the TLC DSS is built using a series of variables. The assessment forms data is directly stored in the system as raw variables. A total of 117 raw variables (marked with an 'R_' in Figure 1) are collected from all the 5 TLC forms. A raw variable simply stores the response for each question in the assessment forms. These raw variables are then combined to calculate intermediate variables (a total of 44). For example, six raw variables are used to assess the level of nicotine dependence of an individual, of which three are shown in Figure 1.

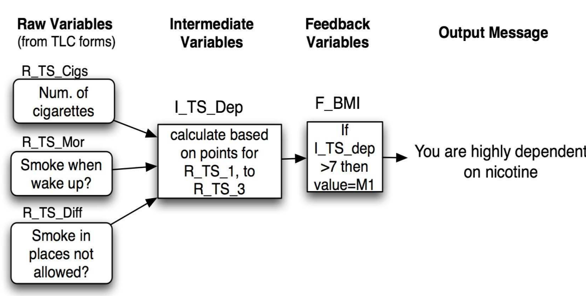

Figure 1. Example of raw, intermediate and feedback variables

These raw variables are then summed to determine the value of one intermediate variable (I_TS_Dep in Figure 1) that stores the nicotine dependence (which in this case can have values of highly dependent, moderately dependant and minimally dependant). The intermediate variables are then used to process the value of the feedback variables, which in turn determine the feedback messages displayed. Continuing with the example in Figure 1, the feedback variable would be set to display the message "based on your assessment, you are highly dependent on nicotine." The tailoring algorithms also have a set of presentation rules that determine the layout of the feedback messages.

Writing the Messages

The TLC system contains a set of generic and tailored messages. We have employed liberal use of graphical icons and visual elements to convey information since our target populations are older patients with lower literacy skills[xviii]. Hence the TLC message library contains several icons and graphical elements (Figure 2). Tailored information is grounded in behavioral theory, and instantiated as personalized tables representing risk of heart disease based on the patient's age, sex and number of cigarettes smoked, and are aimed at increased perceived susceptibility to heart disease. Corresponding visuals showing the dramatic reduction in risk if the patient quits smoking, influence perceived benefits of behavior change.

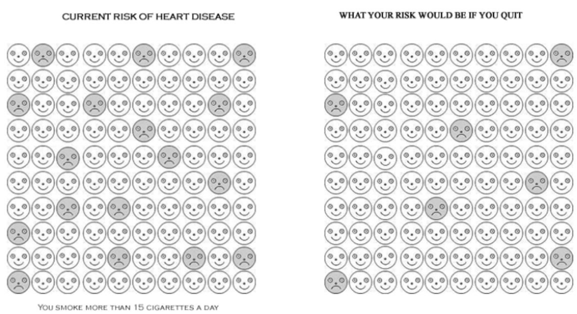

Figure 2. Visual depiction of risk of healthy behavior of individual compared to risk from unhealthy behavior

Designing the feedback output

The TLC system incorporates the tailored feedback into a report on behavioral risks and decision support. The feedback output is divided into four major sections: a) behavioral and clinical risks, b) readiness and confidence for changing each behavior, c) a summary to elicit patient priorities for change and d) an action plan to affirm behavior change plans along with a summary for the provider. The behavioral and clinical risk section is designed to help patients understand their risk factors, and how their risk for heart disease could be reduced if they made lifestyle changes. The risk information is displayed in a visual heuristic (Figure 2), based on prior research on visuals to aid low numeracy populations in parsing probability-based risk information[xix].

The second section displays the readiness and confidence of the individual for each behavior on a "ladder" to represent the progress for each behavior. Finally, the summary recaps the information in a simple, visual, qualitative equation to serve as a decision support tool (Figure 3). The summary section presents the estimated chance of success of changing each health behavior (based on confidence plus readiness levels) as well as the level of health benefit the patient would achieve (based on magnitude of risk). Patients do not necessarily choose to change health behaviors based on medical risk information alone, and this tool aims to help the patient consciously consider other factors that play into this decision. The report also contains two pages that serve as the "Doctor's report" which includes the summary output as shown in Figure 3 and a sheet containing "talking points". These talking points include important behavioral points derived from the assessment (such as "patient has high fatty foods and not enough fruits and vegetables").

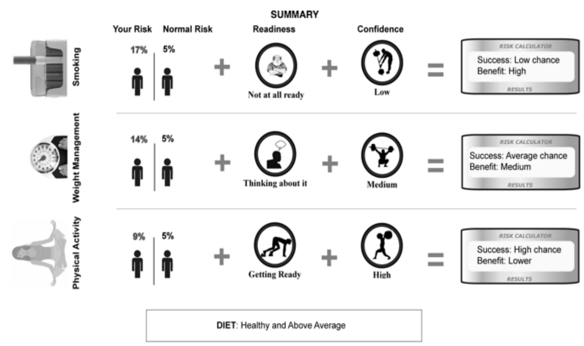

Figure 3. The TLC Output Summary Equation

Technical Development Details

The entire TLC tailoring system has been programmed in the web programming language PHP as a module embedded within a community-driven health website built using Drupal, an open source content management system (CMS)[xx]. The CMS uses a MySQL database and serves request over an Apache web server. Drupal is a highly flexible CMS that provides developers several mechanisms to extend its core functionality. At a high level, the TLC system has four important components: a) the assessment forms tied to a database, b) the decision logic engine, c) portable document format (PDF) output generator and d) an application programming interface (API) to allow external sites to communicate with the TLC system (Figure 4). The development proceeded in a rapid and iterative manner. This entailed weekly iterations of discussing requirements, coding and obtaining feedback.

TLC System Components

The assessment forms are organized into five sections (one for each health behavior and one for the psychosocial assessment). Each section has anywhere from 3-6 web forms to be filled in. Users have the flexibility of starting a TLC assessment and choosing any sequence of section to complete (Figure 4). Data obtained from each section is stored in its own database table with the user identifier and timestamp as the common key across each of the tables. Input values are stored into the database page-by-page; this allows users to stop at any time and then come back to finish the rest of the assessment or to complete some sections and return later to complete all the five sections. After a user finishes all the sections, they are provided a link to view their tailored feedback output. The system provides the ability to see results based on previous assessments or the latest complete assessment, thus allowing them to compare any differences in their health assessment over time.

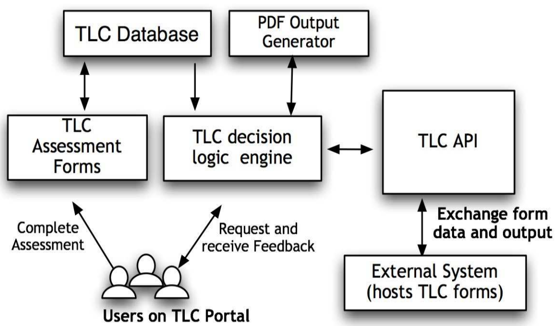

Figure 4. System Components and User Interaction

As the patient requests the tailored output, the tailoring engine is activated (Figure 4). The engine loads assessment data and then sequentially processes the tailoring algorithms. The algorithms are written as if-then-else rules and each rule is coded as a separate function, for modularization. Raw variable values are used to compute the intermediate and feedback variables, which are then passed on to the PDF output generator (Figures 1 and 4).

The generation of the feedback document is performed in real-time and the output is rendered in PDF using a PHP library called, phppdflib[xxi]. The library provides essential functions needed to generate a PDF document including functions to create pages in different formats, control format options such font type or size and to generate the content and output it to the browser. The library provides a root object class within the framework and instantiating the class creates a new document object. Once the object is created, functions in the library are used to set global parameters (akin to setting style properties in HTML) to define the page size, margins, insert page numbers, define document level fonts, headers and other common page elements.

TLC Workflow and Integration

In the current version and setup of the TLC system, patients can fill out the assessments when they visit a community clinic. The assessments currently live within our Drupal-based community health and wellness website. Upon completion of the forms, the system generates the tailored output, which can be printed and given to the patient for discussion with their doctor. In a more generalized model, as an example of which, we integrated the TLC forms within a PHR provided by a commercial vendor, HDOX Inc (http://hdox.com). In this model, the actual tailoring and decision logic engine resides external to the PHR and the two systems communicate assessment data in real-time using the TLC web service API. The TLC API enables external systems to communicate with the decision logic system and to request and receive the feedback output when supplied by a set of inputs. By building an API, we are able to de-couple the decision logic system from the forms and make it easier for a range of systems to get the functionality of the TLC system without requiring custom integration of the decision logic system inside the third-party systems.

Discussion

We have developed a patient-centric decision support system that provides tailored feedback to enable health behavior change conversations between patients and providers. The system is targeted to patients at risk for CVD and uses validated assessments and constructs from health behavior theories. The data elements in the assessment forms extend the clinical data model, which is inadequate to capture information about health behavior and their determinants like self-efficacy[xiii]. The entire system has been programmed and made available within a community-driven website but is designed in such a way that the core tailoring algorithms can receive form data from any other system and send back a tailored output, thus allowing the TLC system to be embedded in other health information systems.

We have conducted preliminary evaluation studies, which are described briefly here. We conducted key informant interviews with patients and physicians using a mock-up of the TLC output. Interviews revealed varying approaches to interpreting the output, suggesting a patient-preference-driven tool may be appropriate. Both patients and providers reacted positively to the tool, and believed it would improve the behavior change discussion. Next, the TLC system was pilot-tested in a community clinic in Harlem for usability and feasibility of implementation with six patients. The preliminary findings support the theoretical and technical framework of TLC and the system was effectively integrated into clinical workflow. The feedback obtained in this study is informing iterative revision of the design and content.

The system has simultaneously been integrated with the HDOX EHR/PHR system. The TLC assessment forms have been programmed in the HDOX PHR. Discussions for similar integrations are underway with organizations using different EHR/PHRs. We are also planning a full evaluation study to determine the effectiveness of the TLC system in promoting patient-provider conversation for behavior change and to do follow-ups with patients to track outcomes.

Conclusion

The TLC system is an innovative approach to enabling patient-provider discussions about lifestyle changes that are based on health behavior theories, incorporate patient preferences and extend the clinical data model of current EHR/PHRs. In addition to mediating conversations, the tailored output can serve to educate and encourage reflection about the possibilities for sustainable health behavior change and CVD risk reduction.

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References

[i] Centers for Disease Control and Prevention. The Burden of Chronic Diseases and Their Risk Factors: National and State Perspectives 2004. Atlanta: U.S. Department of Health and Human Services; 2004.

[ii] Stone NJ, Van Horn L. Therapeutic lifestyle change and Adult Treatment Panel III: evidence then and now. Current Atherosclerosis Reports. 2002 Nov;4(6):433-43.

[iii] Cheng AY, Leiter LA. Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. Current Opinion in Cardiology. 2006 Jul;21(4):

[iv] Whitlock, E.P., et al., Evaluating primary care behavioral counseling interventions: an evidence-based approach. Am J Prev Med, 2002. 22(4): 267-84.

[v] Kreuter MW, Farrell D. Tailoring health messages: Customizing communication with computer technology. Eds Kreuter M, Farrell D, Olevitch L, Brennan P. Lawrence Erlbaum Assoc. 1999.

[vi] Bodenheimer, T. Helping patient improve their health-related behaviors: what system changes do we need? Disease Management 2005:8:319-330.

[vii] Petty RE, Cacioppo JT. The elaboration likelihood model of persuasion. Adv Exp Soc Psychol 1986; 19:123-205.

[viii] Noar, S.M., C.N. Benac, and M.S. Harris, Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. Psychol Bull, 2007. 133(4): p. 673-93.

[ix] Kroeze, W., et al., The efficacy of Web-based and print-delivered computer-tailored interventions to reduce fat intake: results of a randomized, controlled trial. J Nutr Educ Behav, 2008. 40(4): p. 226-36.

[x] Selena D, Abidi SSR. Tailoring cardiovascular risk management education interventions: a synergy of score risk assessment and behavior change model. Stud Health Technol Inform. 2006; 124:235-240

[xi] Prochaska JO, Diclemente CC. Stages and processes of self-change for smoking. J Consu Cli Psyc, 1983. 51:390-395

[xii] Jones B, Abidi S, Winston Y. Using computerized clinical practice guidelines to generate tailored patient education materials. Proc Ann Int Conf Sys Sci. 2005

[xiii] Chan C, Cohall A, Kaufman DR, Khan S, Kukafka R. Selecting data elements to build a patient-centric electronic health record that will support adherence to Therapeutic Lifestyle Change. AMIA Annu Symp Proc. 2008 Nov 6:101-5.

[xiv] Obesity Education Initiative. Aim for a Healthy Weight: Information for Patients and the Public. National Heart Lung and Blood Institute. [cited 2009 March 10]; Available from: http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/risk.htm (Archived by WebCite® at http://www.webcitation.org/5fCPfkuaQ).

[xv] Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. Research Quarterly for Exercise and Sport. 1992;63(1):60-6.

[xvi] Greene GW, Rossi SR, Rossi JS, Velicer WF, Fava JL, Prochaska JO. Dietary applications of the stages of change model. Journal of the American Dietetic Association. 1999;99(6):673-8.

[xvii] Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerstrom test for nicotine dependence: a revision of the Fagerstrom tolerance questionnaire. Addiction. 1991;86(9):1119-27.

[xviii] Osborne H. Health literacy: how visuals can help tell the healthcare story. J Vis Commun Med. 2006. Mar; 29:(1):28–32.

[xix] Ancker J, Senathirajah Y, Kukafka R, Starren J. Design features of graphs in health risk communication: a systematic review. J Am Med Inform Assoc. 2006;13(6):608–18.

[xx] http://www.GetHealthyHarlem.org

[xxi] The PHP PDFlib reference. Available at http://potentialtech.com/pdflibdoc. Last accessed March 12, 2009.