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Personalized Patient Education for Cardiovascular Risk Management: A Synergy of Behavioural Modelling, SCORE and Compositional Information Personalization Methods

Selena Davis, Syed SR. Abidi

NICHE Research Lab, Faculty of Computer Science, Dalhousie University, Halifax, Canada

Abstract

Personalized patient educational programs offer the opportunity to empower patients to self-manage Cardiovascular Disease (CVD) risk. In this paper, we present the PULSE project—Personalization Using Linkages of SCORE and behaviour change readiness to web-based Education—that provides personalized patient education for CVD risk management. Our personalization approach leverages behaviour modelling to ascertain the patient's readiness to uptake any educational interventions and behavioural attitudes towards self-management/improvement. The PULSE framework involves the calculation of the patient's CVD risk using the Systematic COronary Risk Evaluation (SCORE) algorithm, the estimation of readiness to change using the Transtheoretical Model (TTM) of intentional behaviour change, and the representation of personalization logic as Medical Logic Modules (MLM). The educational interventions were derived from evidence-based staged lifestyle modification materials and Canadian clinical guidelines for CVD risk management.

Keywords:

patient education, cardiovascular, risk assessment, behavior modelling, information personalization

Introduction

Patient education, especially for chronic health conditions, is an integral component of disease management at the patient level. In practice, patients are empowered through educational programs that enable them to make informed choices about therapeutic options, risk assessments and lifestyle modification to ensure healthy lives [1].

In general, patient education is practiced through the provision of 'generic' health educational material in the form of print materials (pamphlets or booklets) and/or Internet based health portals. However, despite both the perceived and demonstrated benefits of patient education, there is a noted lack of uptake of conventional patient education programs, despite the apparent ease of access, because the educational material is generally designed to cover the needs of a wider patient population. Patients prefer to receive information that is personalized to their individual needs and situation [1]. Personalized educational interventions are more likely to be read, remembered, experienced as personally relevant, and in turn are more effective in changing health outcomes [2].

We believe that personalized patient educational programs can be made more impacting if we take into account the patient's underlying (a) perceptions and attitudes towards his/her health risks; and (b) behavioural disposition towards the uptake of any risk modification information. Therefore, we argue that the personalization of patient education material should be guided by patient's behavioural readiness to uptake educational interventions (in addition to the patient's health profile). We pursue personalized patient education by (a) *determining* the patient's attitude towards his/her health condition and then establish their readiness level to make lifestyle changes to avoid risky behaviours; (b) *educating* the patient so that he/she contemplates lifestyle changes; and (c) *modifying* the patient's lifestyle through personalized educational material that targets both the patient's behaviour and health conditions.

Our research addresses the generation of personalized patient education programs for CVD risk management. The PULSE project personalizes educational material based on the patient's (a) 10-year risk of fatal CVD calculated using the SCORE algorithm [3]; and (b) readiness to change risky behaviour, which is determined using the TTM of intentional behaviour change, also known as Stages of Change [4]. We developed a novel compositional information personalization method that involves the dynamic composition of a personalized educational package by (i) systematically selecting multiple, topic-specific *snippets* of information based on the patient's behavioural and health profile [5]; and (ii) synthesizing the selected snippets based on a patient-specific presentation template. The personalization logic is derived from Canadian clinical guidelines and behaviour change literature, and is represented using MLMs. The educational material covers both medical and psychosocial aspects of CVD risk management, and is derived from a combination of staged lifestyle modification [6] and non-staged messages based on Canadian clinical guidelines. Finally, a web-based interface is used to present the personalized education material to the patient.

Materials and methods

We pursue fine-grained composition of a patient-specific educational package. Therefore, the entire educational material is decomposed into multiple individual educational messages, called *snippets*, where each snippet addresses a particular health issue, targets a specific set of patient parameters and is relevant to a specific Stage of Change. Our strategy is to construct a document by systematically selecting a set of snippets that are related to the patient's health conditions and behavioural Stage of Change. The patient-specific snippets are then intelligently synthesized to yield a seamless PDF-based personalized educational package. Our compositional information personalization strategy allows a fine distinction between patients and ensures that each patient receives educational interventions that are fine-tuned to his/her health needs and behavioural disposition towards risk management.

Behavior change model

We use the TTM [4] as it guides the patient through the process of modifying problem behaviour(s) and acquiring positive behaviours. We designed educational interventions that correspond to patient's needs at different Stages of Change.

Patient data capture template

The Data Capture Template (DCT) records patient information to guide the generation of personalized educational material. We used the Wellsource Coronary Risk Profile, with some modifications to meet (a) SCORE requirements, and (b) Canadian healthcare standards. The DCT was divided into four distinct sections: (1) Demographic Data; (2) Health History Data; (3) Clinical Data; and (4) Risk Behaviour Data.

Patient profile

The patient profile includes: (a) patient information collected via the DCT; (b) new patient information calculated using the DCT data; (c) the computed SCORE value; and (d) the patient's Stage of Change for each risk behaviour. The profile comprises three components: (i) CVD Risk Profile; (ii) Staged Risk Factor Profile and (iii) Non-staged Risk Factor Profile.

Message library

The message library contains a large volume of topic-specific educational interventions that are represented as 200 *snippets* of information, originating from multiple Canadian sources. At a highest level the snippets were categorized as staged and non-staged. At the next-level, the staged material was categorized into five categories, corresponding to the five Stages of Change. The non-staged material was categorized into six snippet categories—i.e. introductory (opening statements), informational (suitable action), definitional (meaning), motivational (incentive), factual (evidence), and gender-specific.

Personalization decision logic

The personalization decision logic determines the selection of the relevant snippets based on a given patient profile. To establish the decision logic, we first developed a mapping matrix that contained the 14 risk conditions identified in the DCT and potential messages targeting these risk conditions. Next, the matrix was translated into a set of symbolic decision rules—i.e. if-then statements—that map the profile elements in the IF part of the rule to specific messages in the THEN part of the rule. We used MLMs to represent the medical knowledge. In total, we developed around 300 rules and a forward reasoning rule-based engine to execute the rules.

Information presentation template

The information presentation template served as an information-structuring guide to determine the order in which the selected snippets are to be integrated. The template was divided into four sections: (1) The *Introductory* section providing patient's name, date, clinic name and the contents of the personalized document; (2) The *CVD Risk Profile* section providing both textual information and a graphical display of the patient's absolute CVD risk as computed by SCORE. (3) The *Progress* section provides a graphical display of changes in a patient's modifiable risk factor values over time; and (4) The *Risk Factor Management* section provides information on each risk factor relevant to the patient.

Delivery method

In PULSE, the educational material is presented as a PDF file that can be both viewed online (in a web browser) and printed as a document. Interaction with the PULSE system is initiated by a healthcare professional in a primary care setting. The practitioner enters the patient data into the DCT whilst consulting with the patient. Next, the PULSE system generates the personalized educational package for the patient.

Concluding remarks

The PULSE approach presents a personalized patient education system that purports a unique synergy between evidence-guided CVD risk assessment and the TTM for behaviour change readiness. We have developed a novel information personalization method that maps the patient profile to specialized educational interventions that correspond to the patient's physiological data, risk category and behavioural predisposition to lifestyle modifications. PULSE system has been qualitatively evaluated by CVD experts in a clinical setting.

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Address for correspondence

S.S. Raza Abidi, Dalhousie University, email: sraza@cs.dal.ca