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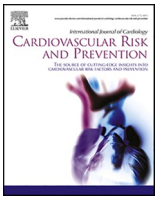

A tool to help patients visualize ASCVD risk and the potential impact of risk-lowering interventions

Keegan Mendez [a,*], Manas Rane [b], Ariela R. Orkaby [c,d,e], J. Michael Gaziano [d,e,f]

[a] Harvard-MIT Program in Health Sciences and Technology, Cambridge, MA, USA
[b] VA Boston Healthcare System, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA
[c] New England GRECC (Geriatric Research Education and Clinical Center) VA Boston Healthcare System, Boston, MA, USA
[d] Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC), VA Boston Healthcare System, Boston, MA, USA
[e] Division of Aging, Brigham and Women's Hospital, Harvard Medical School, Boston, USA
[f] Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, USA

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ABSTRACT

Risk assessment is a fundamental step in the current approach to primary prevention of atherosclerotic cardiovascular disease (ASCVD). When considering pharmacotherapy for primary prevention of ASCVD, current prevention guidelines in the United States recommend the use of the pooled cohort equations (PCE) to assess 10-year ASCVD risk and begin the important process of shared decision-making between patients and clinicians. Clinicians should support patients in the decisionmaking process by turning raw data into information that is easily understood and more effectively utilized for decisions around the treatment plan. In this work, we present a tool to help patients visualize ASCVD risk and the projected impact of risk-lowering interventions. We believe this visual tool can facilitate communication of ASCVD risk to patients, and improve patient understanding of risk and the potential impact of risklowering interventions, which we believe may help patients make more informed, empowered decisions that achieve greater risk reduction.

1. Introduction

Risk assessment is a fundamental step in the current approach to primary prevention of atherosclerotic cardiovascular disease (ASCVD). When considering pharmacotherapy for primary prevention of ASCVD, current prevention guidelines in the United States recommend the use of the pooled cohort equations (PCE) to assess 10-year ASCVD risk and begin the important process of shared decision-making between patients and clinicians [1]. Clinicians should support patients in the decision-making process by turning raw data into information that is easily understood and more effectively utilized for decisions around the treatment plan. For patients to be effective co-participants in the decision-making process, they must be able to understand both their current health risk and the effects of lifestyle changes or therapeutic interventions on their health risk. It is widely accepted that visual displays, such as graphs and pictures, can be used in lieu of numbers or as adjuncts to aid in understanding of numerical risks [2]. Graphical displays, specifically the use of histograms and bar charts, have previously been shown to effectively communicate risk to patients for smoking-related diseases [3], breast cancer [3], prostate cancer [4], and coronary heart disease [5]. While there exist multiple online tools for calculating ASCVD risk (Risk Estimator Plus [6], ClinCalc.com [7]), none of these tools utilize both visual displays and therapy impact projections of potential risk reduction scenarios to support and enhance patient understanding of risk. In this work, we present a tool to help patients visualize ASCVD risk and the potential impact of risk-lowering interventions.

2. Methods

Three functions were written in MATLAB to generate visual displays of risk. *Function 1*: *ASCVD_Calculator* returns the patient's estimated 10-year risk of a first hard ASCVD event (defined as first occurrence of nonfatal myocardial infarction, CHD death, or fatal or nonfatal stroke) using the pooled cohort equations. Equation coefficients and calculation methods were taken from table A of the 2013 ACC/AHA Guideline on

Abbreviations: ASCVD, Atherosclerotic Cardiovascular Disease.

* Corresponding author. MIT E25-319 400 Main Street Cambridge, MA 02142, USA
E-mail address: kmendez@mit.edu (K. Mendez).

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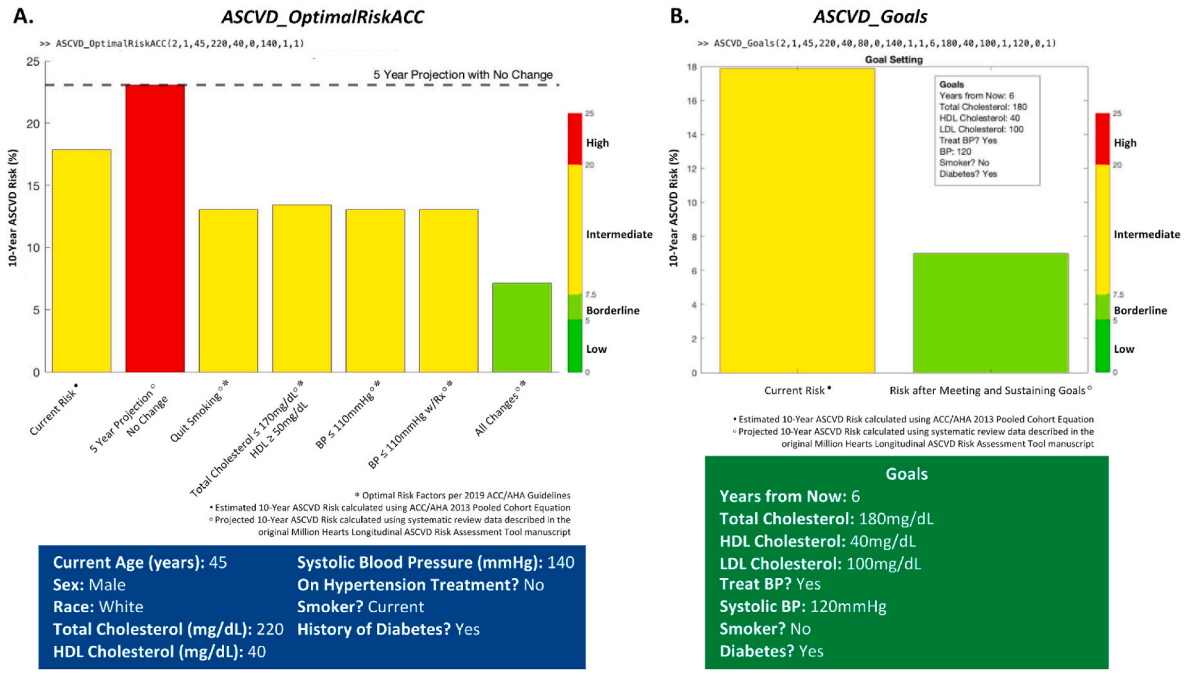

Fig. 1. Use of visualization tool for a hypothetical patient. **(A)** Output of *ASCVD_OptimalRiskACC* showing current risk, five-year projected risk with no change, and projected risk with optimal ACC risk factors. Input patient characteristics specified in blue box. Current risk is calculated using ACC/AHA 2013 Pooled Cohort Equation [8]. Projected risk is calculated using systematic review data described in the original Million Hearts Longitudinal ASCVD Risk Assessment Tool manuscript [9]. Optimal ACC risk factors are taken from the 2019 ACC/AHA Guidelines [1]. **(B)** Output of *ASCVD_Goals* showing current risk and projected risk after meeting and sustaining specified "Goals" for patient described in (A). Input "Goals" specified in green box. Current risk is calculated using ACC/AHA 2013 Pooled Cohort Equation [8]. Projected risk is calculated using systematic review data described in the original Million Hearts Longitudinal ASCVD Risk Assessment Tool manuscript [9].

the Assessment of Cardiovascular Risk [8]. *Function 2: ASCVD_OptimalRiskACC* returns a bar chart with the patient's current estimated 10-year ASCVD risk, the patient's projected risk in 5 years with no changes, and the patient's projected risk with the impact of optimal therapy and/or lifestyle interventions and/or modifications as indicated by the American College of Cardiology (ACC). ACC optimal risk factors include: Total cholesterol $\leq 170 mg/dL$; HDL-cholesterol $\geq 50 mg/dL$; Systolic BP $\leq 110 mmHg$; Not taking medications for hypertension; Not a diabetic; Not a smoker. Projected estimates are a function of the initial 10-year predicted risk and the expected average relative risk reduction associated with a given therapy experienced by participants in randomized clinical trials, using systematic review data described in the original Million Hearts Longitudinal ASCVD Risk Assessment Tool manuscript [9]. Bars are colored according to four discrete clinical risk categories: Low risk ($< 5\%$); Borderline risk ($5 - 7.4\%$); Intermediate risk ($7.5 - 19.9$); High risk ($> 20\%$). *Function 3: ASCVD_Goals* returns a bar chart with the patient's current estimated 10-year ASCVD risk and the projected risk in the specified number of years if all the specified target goals are met. The clinician and/or patient inputs: Number of years to meet goals; Target total cholesterol; Target HDL-cholesterol; Target LDL-cholesterol; Target BP therapy regimen; Target systolic BP; Target smoking status; Target diabetic status. Projected estimates are a function of the initial 10-year predicted risk and the expected average relative risk reduction associated with a given therapy experienced by participants in randomized clinical trials, using systematic review data described in the original Million Hearts Longitudinal ASCVD Risk Assessment Tool manuscript. Bars are colored according to four discrete clinical risk categories: Low risk ($< 5\%$); Borderline risk ($5 - 7.4\%$); Intermediate risk ($7.5 - 19.9$); High risk ($> 20\%$).

3. Results

We created a tool that calculates current and projected estimated 10-year ASCVD risk and visually presents risk data in a bar chart with bars colored according to risk category. Bar charts are presented to patients on-screen and can be printed per patient request. Current estimated 10-year ASCVD risk is calculated using the ACC/AHA 2013 Pooled Cohort Equations (PCE). Projected estimated 10-year ASCVD risk is calculated using systematic review data described in the original Million Hearts Longitudinal ASCVD Risk Assessment Tool manuscript. Fig. 1 demonstrates use of the tool for a hypothetical patient. Fig. 1A shows the output of *ASCVD_OptimalRiskACC* for a patient with the specified input characteristics. Fig. 1B shows the output of *ASCVD_Goals* for the same patient with the specified input "Goals."

4. Discussion

Visual displays enhance our understanding of complex quantitative risk data, as previously demonstrated in lung-cancer [3], breast cancer [3], prostate cancer [4], and coronary artery disease [5]. We developed a tool in MATLAB that enables visualization of current ASCVD risk and how risk changes with the impact of risk-lowering interventions (therapy and/or lifestyle) (Fig. 1A). Our tool also allows for goal setting in which a clinician and patient can agree upon target goals and then calculate and visualize how risk will change over time if these goals are met and sustained (Fig. 1B). We believe this visual tool can assist communication of ASCVD risk to patients, and improve patient understanding of risk and the potential impact of risk-lowering interventions, which we believe may help patients make more informed, empowered decisions that achieve greater risk reduction. This should be tested in a prospective clinical study. While this tool facilitates important clinician-patient discussion and supports decision making around optimization of ASCVD risk, clinicians and patients should be aware of the limitations of population-based risk scores, which have been shown to both overestimate and underestimate ASCVD risk in certain subgroups [10–13]. The information provided by the tool should be integrated in the context of other considerations when creating an optimal treatment plan for the specific patient. This includes weighing the burden and

severity of CVD risk factors, family history, adherence to recommended lifestyle interventions, patient preferences for taking medications, and potential adverse drug reactions.

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Declaration of competing interest

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