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Research Article

Effect of change in systolic blood pressure between clinic visits on estimated 10-year cardiovascular disease risk

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Abstract

Systolic blood pressure (SBP) often varies between clinic visits within individuals, which can affect estimation of cardiovascular disease (CVD) risk. We analyzed data from participants with two clinic visits separated by a median of 17 days in the Third National Health and Nutrition Examination Survey (n = 808). Ten-year CVD risk was calculated with SBP obtained at each visit using the Pooled Cohort Equations. The mean age of participants was 46.1 years, and 47.3% were male. The median SBP difference between the two visits was −1 mm Hg (1st to 99th percentiles: −23 to 32 mm Hg). The median estimated 10-year CVD risk was 2.5% and 2.4% at the first and second visit, respectively (1st to 99th percentiles −5.2% to +7.1%). Meaningful risk reclassification (ie, across the guideline recommended 7.5% threshold for statin initiation) occurred in 12 (11.3%) of 106 participants whose estimated CVD risk was between 5% and 10%, but only in two (0.3%) of 702 participants who had a 10-year estimated CVD risk of <5% or >10%. SBP variability can affect CVD risk estimation, and can influence statin eligibility for individuals with an estimated 10-year CVD risk between 5% and 10%. J Am Soc Hypertens 2014;8(3):159–165.

Keywords: Systolic blood pressure; risk assessment; statins; adults.

Introduction

The newly published American College of Cardiology (ACC)/American Heart Association (AHA) Guideline on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults recommend estimating 10-year cardiovascular disease (CVD) risk using the Pooled Cohort Equations to guide initiation of statin therapy for primary prevention.[1,2] Systolic blood pressure is one of the measures used in the calculation of estimated 10-year CVD risk.[1] Substantial change in systolic blood pressure between sequential clinic visits has been noted in research studies and in clinical practice.[3–6] For example, Rothwell et al demonstrated that 15% to 35% of participants treated for hypertension or who had a prior transient ischemic attack had changes in systolic blood pressure greater than 50 mm Hg across multiple clinic visits.[3] Therefore, systolic blood pressure variability has the potential to affect estimation of an individual's 10-year CVD risk, potentially leading to uncertainty for the classification of patients into risk categories intended to guide prevention efforts. However, scarce data are available on how likely this reclassification is to occur.

With the release of the 2013 ACC/AHA guidelines that emphasize absolute CVD risk for the initiation of statin

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therapy,[2] there is a need to characterize the impact of changes in systolic blood pressure across clinic visits on the stability of CVD risk estimation. To address this, we used data from the subset of participants in the Third National Health and Nutrition Examination Survey (NHANES III) who completed two clinic visits over a period of several weeks, to determine the effect of changes in systolic blood pressure across visits on changes in estimated 10-year CVD risk.

Methods

NHANES III was a cross-sectional survey designed to select a representative sample of the civilian non-institutionalized US population.[7] The protocol for NHANES III was approved by the National Center for Health Statistics of the Centers for Disease Control and Prevention Institutional Review Board, and all participants provided informed consent. Over the survey period of 1988 to 1994, 18,825 adults ≥20 years of age completed an in-home interview and a visit to a mobile clinic (Visit 1) for medical evaluation including three blood pressure measurements. A subsample (n = 2174) attended a second visit at the mobile clinic (Visit 2), at which time the medical evaluation, including three blood pressure measurements, was repeated. The median duration between the two clinic visits was 17 days (range, 1 to 48 days). Although more recent NHANES are available, we chose to analyze NHANES III as it has data from a second study visit allowing for the calculation of variability of blood pressure across two study visits. For the current analyses, we included NHANES III participants who had two clinic visits with three blood pressure measurements performed in the same arm at each visit (n = 956). We excluded 32 participants missing data on measures (eg, total cholesterol) needed to calculate estimated 10-year CVD risk, and 116 participants with a history of coronary heart disease (CHD), diabetes, or stroke, as they would be classified as having high CVD risk based on medical history alone.[2] After these exclusions, 808 participants were included in this analysis.

Data Collection and Blood Pressure Measurement

Demographic and health-related information including age, gender, race/ethnicity, and smoking status was collected using a standardized questionnaire during the in-home interview. The use of anti-hypertensive medications was ascertained via self-report. Blood specimens were collected during the medical evaluation to determine total cholesterol and high-density lipoprotein (HDL) cholesterol levels. Blood pressure was measured three times during each of the two clinic visits, with the average of the second and third measurements recorded as the blood pressure for that visit. Blood pressure measurements were performed by a trained clinician using the standard protocol of the AHA at both clinic visits. Each participant's arm was measured to determine the appropriate sized cuff. Participants were asked to remain in a seated position for 5 minutes of quiet rest prior to their first blood pressure measurement being taken. Quality control for the blood pressure measurements included quarterly recertification with retraining if necessary, annual retraining of all physicians, and monitoring of equipment and equipment repair. Additional details regarding blood pressure measurement and quality control procedures are provided in the NHANES III manual of operations.[7]

Statistical Analysis

At each clinic visit, we calculated the participant's estimated 10-year CVD risk using the Pooled Cohort Equations based on age, gender, race, systolic blood pressure, total cholesterol, HDL cholesterol, smoking status, and use of antihypertensive medication.[1] In order to isolate the effect of systolic blood pressure variability on estimated 10-year CVD risk, we used the systolic blood pressure measured at each visit, while assuming other parameters (eg, cholesterol levels, smoking status) remain unchanged from the first visit. We then computed the difference in 10-year CVD risk estimates calculated at the two visits, defined as the risk estimate from Visit 2 minus the risk estimate from Visit 1. The summary measures for number of days between clinic visits, systolic blood pressure, diastolic blood pressure, and the estimated 10-year CVD risk at each visit were expressed as medians and 25th to 75th percentiles due to non-normal distributions of these variables. Agreement between the two 10-year CVD risk estimates was assessed using a Bland-Altman plot,[8] and the proportion of individuals with ≥1%, ≥2%, ≥3%, ≥4%, and ≥5% absolute change in estimated 10-year CVD risk across two clinic visits was calculated. Next, we examined the effect of change in blood pressure on change in estimated 10-year CVD risk across two visits. First, we calculated the percentage of participants with systolic blood pressure <130, 130 to <150, and ≥150 mm Hg and diastolic blood pressure <75, 75 to 84, and ≥85 mm Hg at the first visit who experienced ≥3% absolute change in estimated 10-year CVD risk between Visit 1 and Visit 2; ≥3% was chosen to represent a change large enough to have potential clinical relevance. Using logistic regression models with systolic blood pressure <130 mm Hg as the reference group, we analyzed whether systolic blood pressure between 130 to <150 mm Hg and ≥150 mm Hg at time of Visit 1 were associated with a ≥3% absolute change in estimated 10-year CVD risk at Visit 2 after multivariable adjustment. An initial model adjusted for age, gender, race-ethnicity, and a second model further included additional adjustment for diastolic blood pressure. Logistic regression models were also constructed for diastolic blood pressure (<75 [reference], 75 to 84 and ≥85 mm Hg) with two levels of adjustment for age, gender, race-ethnicity (Model 1), and age, gender, race-ethnicity, and systolic blood pressure (Model 2).