Original Investigation | August 03, 2016

An Electrocardiogram-Based Risk Equation for Incident Cardiovascular Disease From the National Health and Nutrition Examination Survey

ONLINE FIRST

Amit J. Shah, MD, MSCR[1,2,3]; Viola Vaccarino, MD, PhD[1,2]; A. Cecile J. W. Janssens, PhD[1,4]; W. Dana Flanders, PhD[1]; Suman Kundu, MSc[1]; Emir Veledar, PhD[1,2,5]; Peter W. F. Wilson, MD[2,3]; Elsayed Z. Soliman, MD, MS, MSc[6,7]

[+] Author Affiliations

JAMA Cardiol. Published online August 03, 2016. doi:10.1001/jamacardio.2016.2173

ABSTRACT

Importance Electrocardiography (ECG) may detect subclinical cardiovascular disease (CVD) in asymptomatic individuals, but its role in assessing adverse events beyond traditional risk factors is not clear. Interval and vector data that are commonly available on modern ECGs may offer independent prognostic information that improves risk classification.

Objectives To derive and validate a CVD risk equation based on ECG metrics and to determine its incremental benefit in addition to the Framingham risk score (FRS).

Design, Setting, and Participants This study included 3640 randomly selected community-based adults aged 40 to 74 years without known CVD from the First National Health and Nutrition Examination Survey (NHANES I) cohort (1971-1975) and 6329 from the NHANES III cohort (1988-1994). Participants were sampled from across the United States. A risk score to assess incident nonfatal and fatal CVD events was derived based on computer-generated ECG data, including frontal P, R, and T axes; heart rate; and PR, QRS, and QT intervals from NHANES I. The most prognostic variables, along with age and sex, were incorporated into the NHANES ECG risk equation. The equation was evaluated in the NHANES III cohort for an independent validation. Follow-up in the NHANES III cohort was completed on December 31, 2006. Data for this study were analyzed from August 11, 2015, to May 20, 2016.

Main Outcomes and Measures The primary end point was CVD death. Secondary outcomes included 10-year ischemic heart disease and all-cause death.

Results The final study sample included 9969 participants (4714 men [47.3%]; 5255 women [52.7%]; mean [SD] age, 55.3 [10.1] years) from both cohorts. Frontal T axis, heart rate, and heart rate–corrected QT interval were the most significant ECG factors in the NHANES I cohort. In the validation cohort (NHANES III), the equation provided for prognostic information for fatal CVD with a hazard ratio (HR) of 3.23 (95% CI, 2.82-3.72); the C statistic was 0.79 (95% CI, 0.76-0.81).

When added to the FRS in Cox proportional hazards regression models, the categorical (1%, 5%, and 10% cutoffs) net reclassification improvement was 24%. When the FRS and ECG scores were combined in a single model, the C statistic improved by 0.04 (95% CI, 0.02-0.06) to 0.80 (95% CI, 0.77-0.82). Similar improvements were noted when the ECG score was added to the pooled cohort equation. When the equation for prognostic information about ischemic heart disease and all-cause death was evaluated, the results were similar.

Conclusions and Relevance An ECG risk score based on age, sex, heart rate, frontal T axis, and QT interval assesses the risk for CVD and compares favorably with the FRS alone in an independent cohort of asymptomatic individuals. Although the ECG risk equation is low cost, further research is needed to ascertain whether this additional step in risk stratification may improve prevention efforts and reduce CVD events.