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Utility of Framingham Risk Score in Urban Emergency Department Patients with Asymptomatic Hypertension

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Abstract

Hypertension (HTN) is the primary population-attributable risk for the development of heart failure (HF); a disease with devastating consequences particularly in urban centers where morbidity and mortality are more pronounced. The Framingham Risk Profile (FRP) is widely used to quantify risk for cardiovascular disease (CVD), but its applicability in an urban population who utilize the emergency department (ED) for primary care is unknown. Our objective for this study is to evaluate FRP scores in ED patients with asymptomatic HTN and subclinical hypertensive heart disease (SHHD). This is a sub study of a prospective randomized clinical trial designed to evaluate optimal blood pressure (BP) targets. Eligible patients were screened with echocardiography for the presence of SHHD and FRP scores were calculated. 149 patients enrolled in the study, 133 (89.2%) of whom had detectable SHHD. Mean [SD] calculated FRP scores were statistically similar for patients with SHHD vs. those without (general CVD: 20.2 [8.5] vs. 15.6 [8.7]; p=0.13 and HF calibrated: 2.4 [1.0] vs. 1.8 [1.0]; p=0.12) corresponding to a calculated risk of 15%–30% for subsequent development of CVD. The HF specific risk score for patients with SHHD was 2.4, which equates to a 2.5% risk of HF development in 10 years. The FRP correctly identified those with SHHD as high-risk for general CVD but appeared to underestimate the likelihood of HF. Recalibration of the HF adjustment factor and inclusion of additional data elements such as echocardiography is needed to enhance applicability of the FRP in this setting.

Keywords

Hypertension; Heart Failure; Subclinical Hypertensive Heart Disease; Health Disparities; Echocardiography

Background

Heart failure (HF) is a devastating disease, which is extremely prevalent in the developed world. An estimated 5 million Americans suffer from HF and this condition was implicated as the primary cause of death in 56,000 patients in 2009[1]. As demonstrated in the findings of

three, large, community-based studies, the mean survival after a diagnosis of HF is dismal, ranging from 33% - 52% at 5 years[2–4].

Hypertension (HTN) is the primary population-attributable risk factor for the development of HF [5,6]. This especially pronounced in African Americans who have a higher prevalence of HTN induced HF and die earlier from the disease once diagnosed [1,7–910]. Early detection of subclinical hypertensive heart disease (SHHD), a precursor to development of symptomatic HF, can help mitigate such risk by permitting initiation of secondary preventative measures including medical therapy and lifestyle changes [11]. Echocardiography can be particularly useful for this providing a non-invasive means of cardiac structural and functional assessment. Recent studies have shown that sonographic findings of SHHD, such as left ventricular hypertrophy (LVH), correlate well with the natural progression to HF[12–14]. Additionally, regression of LVH has been associated in a recent meta-analysis with a reduction in the risk HF along with other cardiovascular diseases (CVD)[15].

While early treatment of those with SHHD is ideal, echocardiographic assessment of all patients with HTN would be a costly endeavor. Instead a targeted approach to screening would optimize efficiency. The Framingham Cardiovascular Risk Score is a widely used population-based algorithm for determination of general and disease specific CVD risk[16,17]. However, it was designed for primary care physicians and there has been little investigation of its use in other settings. Accordingly, we designed this study to assess the potential utility of Framingham Risk estimation in a cohort of patients with asymptomatic HTN recruited from an urban emergency department (ED). We hypothesized that the Framingham risk scores, which were based on a white, suburban cohort would underestimate the level of risk in our study population.

Methods

This is a pre-specified sub-analysis of a prospective, randomized trial that sought to define optimal blood pressure (BP) targets in a cohort of patients with asymptomatic blood pressure elevations and SHHD recruited from a single, urban ED (Detroit Receiving Hospital; Detroit, MI). Inclusion criteria for the parent trial were persistently elevated BP (>140/90) on 2 separate, automated, oscillometric brachial cuff measurements at least 1 hour apart, age ≥35 years, and asymptomatic state as defined by the Goldman specific activity scale[18]. As the parent study was focused on SHHD, patients with dyspnea or chest pain as a chief complaint, prior history of HF, coronary artery disease, myocardial infarction, cardiomyopathy, valvular heart disease, renal failure, or need for admission to hospital on index ED visit were excluded. In addition, because the intent was to randomize patients to more intensive BP control (< 120/80 mm Hg) vs. usual care (< 140/90 mm Hg and < 130/80 mm Hg for subjects with chronic kidney disease or diabetes, according to the recommendations of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure[19] [JNC-7]), those with a standing primary care provider relationship were also excluded.

Upon study enrollment but prior to randomization, baseline data were compiled, an echocardiogram was obtained, and blood/urine samples for laboratory analysis were

collected. All echocardiograms were interpreted by a single, board-certified cardiologist who was blinded to clinical data and, for purposes of the study, SHHD was defined by the presence of one or more of the following validated findings: left ventricular (LV) hypertrophy (LV mass ≥48 g/$m^{2.7}$ in males or ≥45 g/$m^{2.7}$ in females), LV systolic dysfunction (ejection fraction < 50%), or LV diastolic dysfunction (combination of parameters based on validated criteria of LV stiffness and relaxation)[13,14,20]. Subjects with SHHD were then randomized to one of our two BP target groups. Patients were followed quarterly in a dedicated HTN research clinic where antihypertensive pharmacological treatment was titrated according to study arm. All medications were provided to participants free of charge, and transportation was provided when needed. Echocardiograms were repeated at the final clinic visit to assess regression of SHHD.

Data Analysis

Framingham 10-year general CVD risk scores[16] and 10-year calibrated HF specific risk scores[17] were calculated for all subjects enrolled in the study regardless of whether or not SHHD was present and serve as the focus of this sub-analysis. Continuous variables were tested for and found to have normal distribution. Univariate comparisons were made using t-tests for continuous measures and the chi squared test for categorical data. Significance was determined at $p < 0.05$. Data were analyzed by an independent biostatistician using SAS software (v 8.2).

Results

A total of 149 subjects were enrolled in the study and 133 (89.2%) had echocardiographic evidence of SHHD. As shown in Table 1, subjects with SHHD were more likely to be African Americans (95.6% vs. 72.7%; $p < 0.0001$) and their screening systolic BP was significantly higher by a mean difference of 27 mm Hg (181 [SD 21] mm Hg vs. 157 [SD 11] mm Hg; $p < 0.0001$).

Framingham Risk Scores for both groups are displayed in Table 2. For those with and without SHHD, the general CVD risk score was relatively high with no significant difference between groups. The calibrated HF specific risk scores were also similar, but the projected probability of HF development within 10-year was quite low (2.5%), even among those with SHHD.

Discussion

In this cohort of predominantly African-American ED patients with asymptomatic HTN, SHHD was quite common. That we found relatively high Framingham general CVD risk scores among study patients is thus not surprising and is consistent with overall impressions of increased risk in populations such as ours. This is consistent with previous studies that validated the Framingham CVD risk algorithm in African American populations[21,22]. However, to our knowledge this is the first time that the Framingham CVD risk score has been applied to a population at such high risk for hypertensive end organ damage [23] and our findings may guide future efforts aimed at risk stratification of ED patients with severely elevated BP[24].

In contrast, the calibrated Framingham HF specific risk score appears to dramatically underestimate risk of subsequent cardiac dysfunction in this population. Subclinical hypertensive heart disease is a well-recognized precursor to symptomatic HF development [12–14], and ideally this should be better reflected in respective risk prediction models such as Framingham. Such a discrepancy is likely due to the largely white cohort from which Framingham scores were derived. As demonstrated in both Multi-ethnic Study of Atherosclerosis (MESA) [25] and Atherosclerosis Risk in Communities (ARIC) [26] prediction of incident HF may be more accurate when greater weight is applied to BP for African Americans as HTN is the predominant cause of HF in this population.

Beyond ethnic and socioeconomic variations, the utility of traditional risk score algorithms for prediction of CVD has been called into question by several authors, as they tend to be highly sensitive, but poorly specific. Additional diagnostic tests proposed to increase the specificity include coronary artery calcium, echocardiography, and carotid artery intimal thickness among others[27–29]. Cohn et al. proposed a new risk classification, the Rasmussen score, which integrates advanced, non-invasive vascular testing, echocardiography, serum biomarkers, electrocardiogram, and exercise stress testing with resting BP to predict atherosclerotic heart disease[30]. This risk score appears to outperform the Framingham score in preliminary data[31], but will still require additional validation studies before large scale implementation. While this specific array of tests may not be cost effective in our high-risk population, in the quest to develop a parsimonious yet accurate risk stratification tool for specific populations some of these tests, especially echocardiogram, may prove to be quite useful for risk assessment.

Conclusions

While our findings support the utility of the Framingham General CVD Risk Score in African American patients with elevated BP in the ED, they also underscore the inadequacy of such traditional risk assessment in a population where SHHD is highly prevalent. Future research focused on development and validation of an approach to risk assessment that takes into account factors contributing to specific types of CVD such as HF is needed. For African Americans, in particular, liberal use of echocardiography may be an important part of this process, enabling detection of SHHD, an important precursor of HF that can be reversed with early diagnosis and treatment.

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Table 1

Baseline Comparison of SHHD vs. non-SHHD

Variable	No SHHD *n*=16	SHHD *n*=133	*p* value
Mean Age in Years (SD)	47.9 (7.1)	49.5 (8.4)	0.54
Male Gender (%)	63.6	63.0	0.51
African-American race (%)	72.7	95.6	<0.0001
Mean body mass index (SD)	30.0 (8.0)	32.0 (6.1)	0.36
Mean duration HTN in years (SD)	4.3 (7.9)	8.1 (9.7)	0.36
History of diabetes (%)	0.0	7.5	0.81
Cigarette smoking (%)	45.4	54.7	0.17
Mean systolic BP at screening in mm Hg (SD)	157.2 (11.4)	181.4 (21.1)	<0.0001
Mean diastolic BP at screening in mm Hg (SD)	96.7 (7.0)	105.0 (12.1)	0.03
Mean serum total cholesterol mg/dl (SD)	198.8 (32.7)	199.5 (32.7)	0.96
Mean serum HDL mg/dl (SD)	52.5 (20.4)	50.0 (14.5)	0.64

SHHD - Subclinical hypertensive heart disease, HTN – hypertension, BP – blood pressure, HDL – high-density lipoprotein

Table 2

Framingham CVD and HF Risk Scores

Variable	No SHHD n = 16	SHHD n = 133	p value
Mean (SD) Framingham Risk Score 10 year CVD	15.6 (8.7)	20.2 (8.5)	0.13
Probability of developing CVD	25% (Male) 15% (Female)	30% for Males and Females	N/A
Mean (SD) Framingham Risk Score 10 year HF	1.8 (1.0)	2.4 (1.0)	0.12
Probability of developing HF	2.5%	2.5%	N/A

SHHD - Subclinical hypertensive heart disease, CVD - cardiovascular disease, HF – heart failure